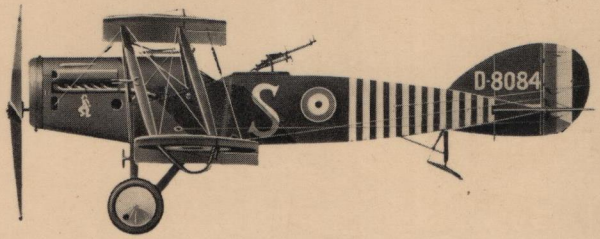
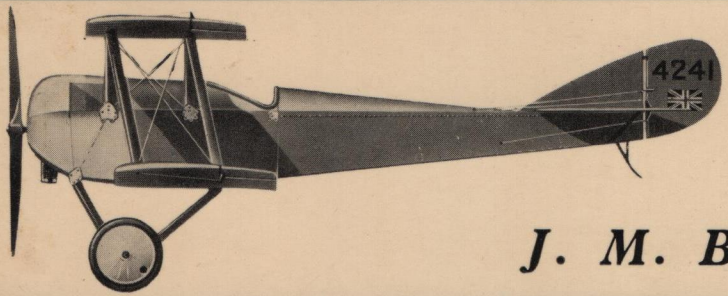
WAR PLANES OF THE FIRST WORLD WAR

FIGHTERS

VOLUME ONE





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WARPLANES OF THE FIRST WORLD WAR

Volume I

FIGHTERS

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J. M. Bruce, world authority on this period of flying history, has provided in this series a compact and authoritative source of reference to all known aircraft built by the combatant nations during the First World War. This is the first volume on Fighters in the series which is in uniform with William Green's *Warplanes of the Second World War*.

World War I was the first major conflict in which aircraft were used. From the tentative experimental designs and ideas of 1914 and 1915 there evolved an astonishing and fascinating armoury of aeroplanes, weapons and techniques. In the process of evolution almost any with promise was tried. This volume includes early fighters such as the Austin Greyhound, the Bristol Badger, Parnall Scout and Avro Spider. Each type has been illustrated by photographs and general arrangement drawings.

Much material in the series has never before been published. The books are a must for all who are interested in aircraft history, and the full series will form the most complete source of reference to 1914-18 aircraft available.

WAR PLANES OF THE FIRST WORLD WAR

FIGHTERS

VOLUME ONE

GREAT BRITAIN

J. M. BRUCE

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INTRODUCTION

When war came to Europe in August 1914 few military minds had any clear conception of the part that aircraft would play in the conflict; fewer still saw the aeroplane as anything but a reconnaissance vehicle. A few visionaries had foretold fighting in the air, but their predictions, if not laughed to scorn, were not taken seriously. Yet the war was barely two months old when, on 5th October 1914, a French air mechanic named Quénault, flying as the observer of a Voisin biplane piloted by Sergeant Frantz, shot down a German aircraft.

Such fast single-seaters as existed at the time were regarded as high-speed reconnaissance aircraft. Although they responded readily enough to the combat demands that came to be made of them, they never lost the original name of scout; during the war at least it became synonymous with fighter.

As the war in the air developed, many things were found for aircraft to do. This was reflected in the profusion of widely differing aeroplane types produced by all the combatant nations. Partly for this reason, partly because so many of the early 1914–18 aircraft performed, or attempted, any or all of the tasks given to the air forces of the time, it is difficult to allocate some of them to precise fighter, bomber or reconnaissance categories.

Thus in this series the volumes dealing with fighters will include aircraft that were never intended for the phrenetic maelstrom of the dogfight but were designed as reconnaissance machines, high-speed scouts, airship destroyers or ground-attack aircraft. Those that were armed had a gun as their primary weapon; their fighting function was to bring that gun to bear on some unit of the enemy's forces. Those that had no such weapon might have been fighters had they been armed; it therefore seems more appropriate to allocate them to the fighter aircraft volumes than to any others. The true fighter aircraft preponderate, of course. The Somme finally established their distinctive trade, and it was at about that time that successful machine-gun synchronizing gears began to be generally introduced. Thereafter the designers' quest was the perpetual pursuit of speed, climb, manoeuvrability, and a good view from the cockpit.

There are some people without whose aid any history of 1914–18 aircraft could not be adequately compiled. I gratefully acknowledge the help and contributions of C. H. Barnes, Frank Cheesman, Stuart Leslie, Ken Molson, Bruce Robertson and Wing Commander N. H. F. Unwin, and the assistance of Ann Tilbury of *Flight International* and Frank Smith, Librarian of the Royal Aeronautical Society. A special acknowledgment is due to Don Clayton and Derek Tattersall, who have devoted untold hours and effort to producing the excellent three-view drawings. Their painstaking efforts enable this book to present accurate general-arrangement drawings of many aircraft never previously depicted in this way.

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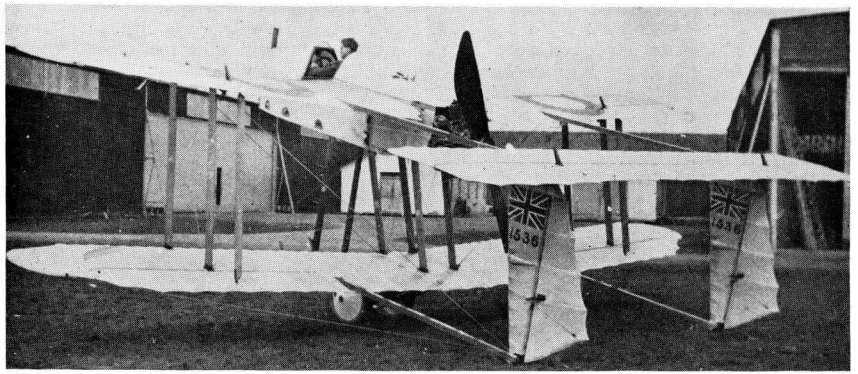
A.D. SCOUT

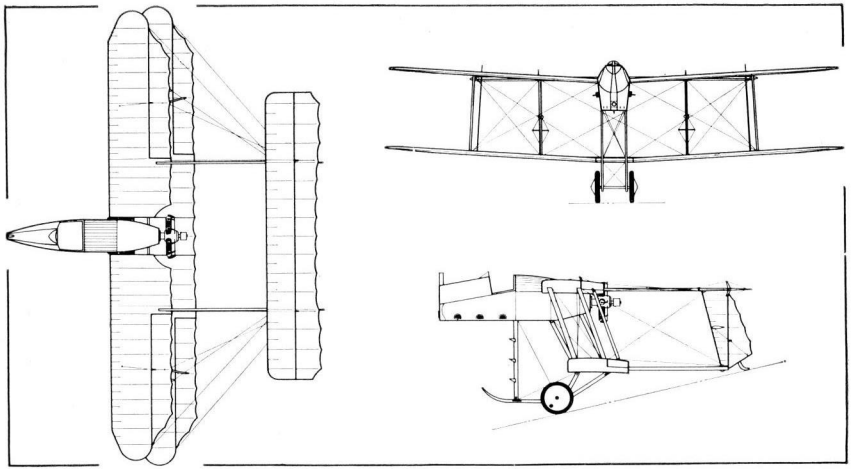
In 1915 the Admiralty required a fighter aircraft capable of carrying the Davis recoilless quick-firing gun and of serving in the anti-airship rôle. To meet this requirement, Harris Booth of the Air Department of the Admiralty designed an unusual single-seater, powered by a 100 h.p. Gnôme Monosoupape rotary engine.

It was decided that the new A.D. Scout should be built of commercial materials that would be more readily available than some of the special steels and other materials that were required for most contemporary aircraft. All of its metal fittings were to be made of ordinary mild steel; an inexpensive form of turnbuckle was designed for the aircraft. Materials apart, the A.D. Scout was structurally quite conventional, having a wire-braced, fabric-covered wooden airframe. All trailing edges were of wire.

But in appearance it was markedly unconventional. It was a pusher, with the nacelle mounted high in order to give the pilot a good field of view: in fact the spars of the upper wings passed under the upper longerons of the nacelle. The tailbooms, supporting an enormous tailplane, were parallel in plan and elevation; the twin fins and rudders were thus widely spaced some eleven feet apart. Since this was so, it was thought that only one further point of support was required in the undercarriage. To use only one wheel was



Blackburn-built A.D. Scout No. 1536 at Chingford.

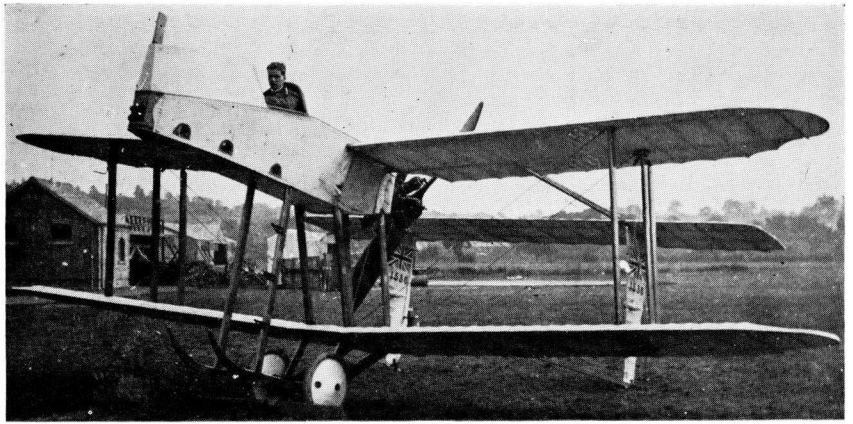


considered impossible, however, and there were two landing wheels mounted unusually close together on two parallel skids.

Four prototypes were ordered: Nos. 1452 and 1453 from Hewlett & Blondeau, Ltd., Nos. 1536 and 1537 from the Blackburn Aeroplane & Motor Co.: it seems likely that all were completed. Hewlett & Blondeau were understandably uneasy about the practicality of the A.D. Scout's peculiar undercarriage. With the concurrence of A. W. Stedman of the Air Department they designed and built an alternative undercarriage with wider track. This modification was not approved, however, and the firm were instructed to deliver the aircraft to the R.N.A.S. aerodrome at Chingford.

Of the Blackburn-built aircraft, No. 1536 is known to have been delivered to Chingford. It is believed that the completed aircraft were considerably heavier than the estimated weight, and that they proved to be unsatisfactory in the air. The type was not developed, but during its brief existence it earned the nickname "Sparrow".

Type: *Single-seat anti-airship Fighter.* **Power:** *One 100 h.p. Gnôme Monosoupape nine-cylinder rotary engine.* **Armament:** (*Proposed*) *One two-pounder Davis recoilless gun.* **Performance:** *No details available.* **Weights:** *No details available.* **Dimensions:** *Span,* 33 *ft.* 5 *in.; length,* 22 *ft.* 9 *in.; height,* 10 *ft.* 3 *in.*



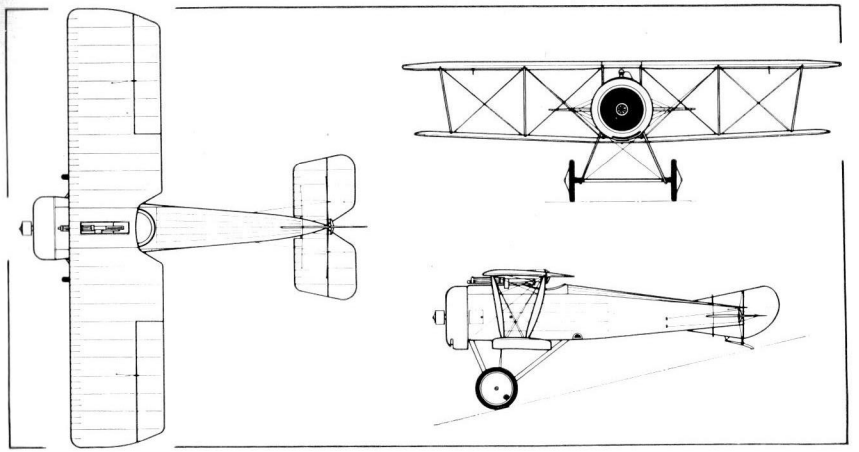
The Blackburn-built A.D. Scout.

ALCOCK A.1

John Alcock had made a name for himself as a pilot in the two years preceding the war; less than eight months after the Armistice, he and Arthur Whitten-Brown won immortality with their transatlantic flight.

On the outbreak of war Alcock joined the R.N.A.S. After two frustrating years on instructional duties at Eastchurch he was posted to No. 2 Wing R.N.A.S., Mudros, in the Aegean theatre of war. There he flew a variety of aircraft, including the Sopwith triplane and Camel.

In the summer of 1917 Alcock made an aeroplane of his own. It was a single-seat fighter, well proportioned and of clean lines. The Alcock Scout embodied several Sopwith components. The forward portion of the fuselage and the lower wings had been modified from triplane components, and the upper wings were basically those of a Sopwith Pup. Two-bay interplane bracing was employed; the ailerons, which were fitted to the upper wing only, extended inboard as far as the inner struts and were appreciably longer than those of the Pup. The tailplane and elevators had once belonged to a Camel; the rear fuselage

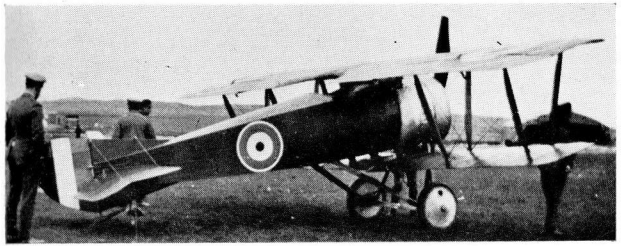


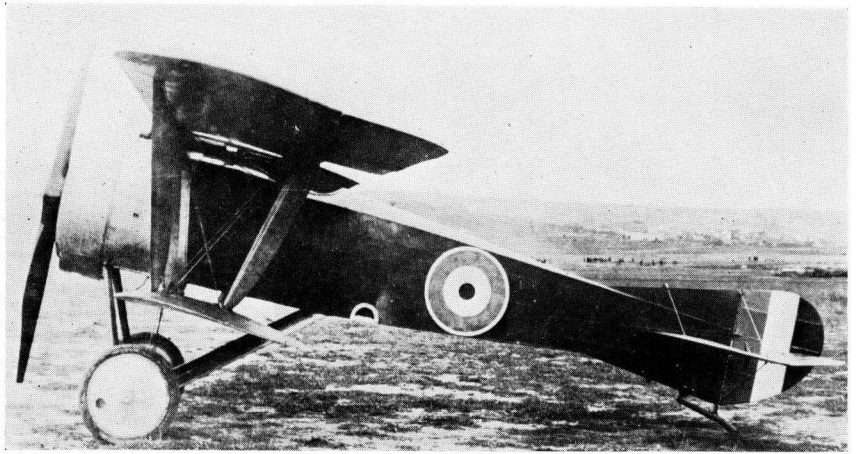
and fin and rudder were of original design. In recognition of its part parentage, Alcock called his scout the Sopwith Mouse.

The fuselage was mounted in mid-gap, thus bringing the upper wing level with the pilot's eyes, where it least obscured his field of vision. The engine was a 110 h.p. Clerget. It has been reported that a 100 h.p. Gnôme Monosoupape was originally installed, but this is doubtful. A single Vickers gun was mounted centrally on top of the forward fuselage.

Alcock was denied the pleasure of flying his creation, for he was taken prisoner on 30th September 1917, before

The Alcock A.1.





The Alcock A.1 at Mudros.

the A.1 was completed. It seems probable that the aircraft first flew on 15th October, 1917, when it proved to be fast and manoeuvrable.

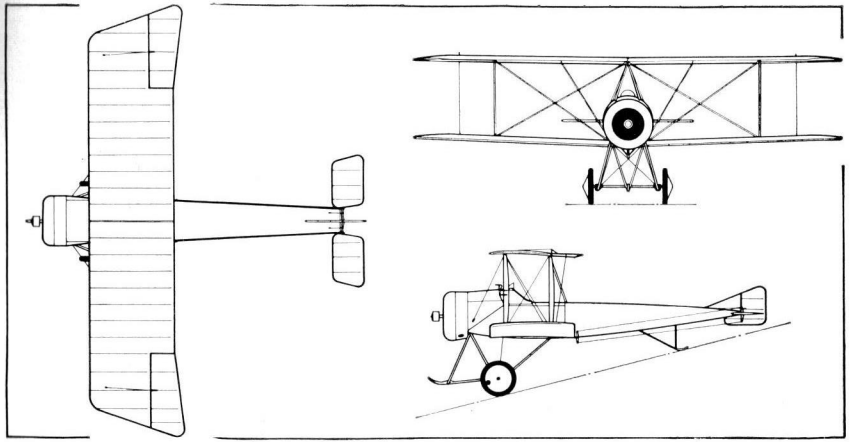
The Alcock Scout was flown at Mudros and Stavros, notably by F/Lt. Starbuck. It was finally written off in a crash.

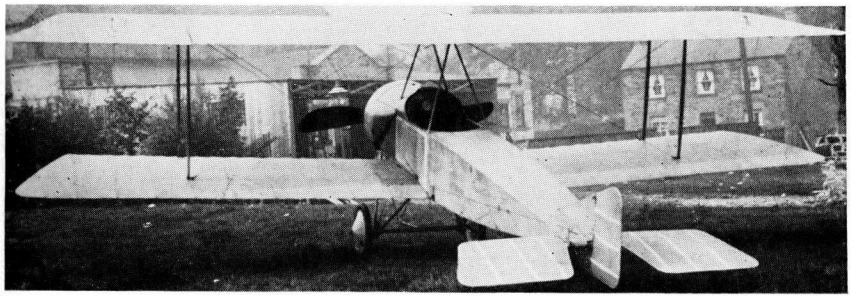
Type: *Single-seat Fighter.* **Power:** *One* 110 *h.p. Clerget 9Z nine-cylinder rotary engine.* **Armament:** *One fixed* 0.303-*in. Vickers machine-gun.* **Performance:** *No details available.* **Weights:** *No details available.* **Approximate dimensions:** *Span (upper),* 24 *ft.* 3 *in., (lower),* 23 *ft.; length,* 19 *ft.* 1½ *in.; height,* 7 *ft.* 9 *in.*

ARMSTRONG-WHITWORTH F.K.1

The Newcastle engineering firm of Sir W. G. Armstrong, Whitworth & Co. Ltd., opened an aircraft department in 1914. Its general manager was Captain I. Fairbairn-Crawford, its chief designer Frederick Koolhoven.

Koolhoven was a Dutchman who, at the age of 25, had joined the French Deperdussin company and had played a leading part in the design of the fast racing Deperdussins. He transferred to the British Deperdussin Co.,



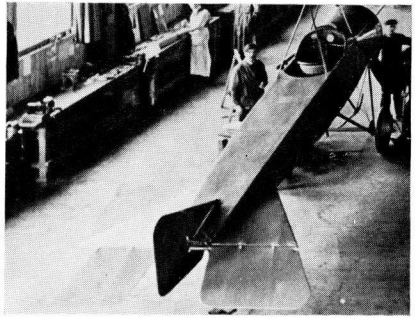


The F.K.1 with original ailerons.

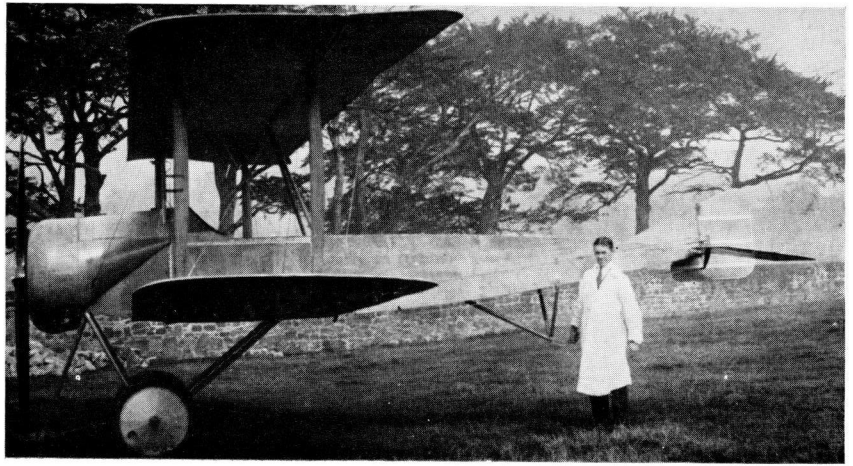
where he designed several aircraft; thence to the Armstrong-Whitworth Co.

The first aeroplane he designed for Armstrong-Whitworth was the F.K.1. It was originally conceived as a monoplane but the design was revised and it emerged as a single-seat biplane with single-bay wings; ailerons were fitted to the upper wing only. It was intended to have the 80 h.p. Gnôme engine, but had to make do with a 50 h.p. Gnôme. There was no fixed tailplane; the balanced elevators were similar to those of contemporary Morane-Saulnier designs.

On its first flight the F.K.1 was flown by

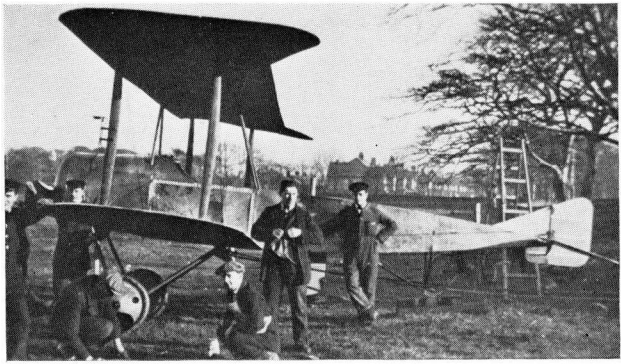


Right, F.K.1 fuselage with tailplane fitted, and, below, F.K.1 with original ailerons.



Koolhoven himself. The burly Dutchman's great weight taxed the underpowered little aeroplane, which struggled off the ground and flew twice round the Town Moor at Newcastle at a height of about 50 ft.

Enlarged ailerons were subsequently fitted, and at a later stage a fixed tailplane and plain elevators replaced the original Morane-like elevators. Development of the F.K.1 was not pursued, however, and it is doubtful whether it was ever seriously considered as a military aircraft of any kind. It provides an interesting comparison with the contemporary Sopwith, Bristol and Martinsyde single-seat scouts.



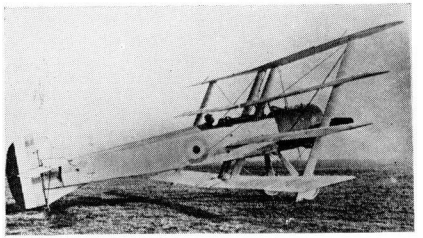
F.K.1 with enlarged ailerons.

Type: *Single-seat Scout.* **Power:** *One* 50 *h.p. Gnôme seven-cylinder rotary engine.* **Dimensions:** *Span,* 26 *ft.* 10¾ *in.; length,* 24 *ft.* 3¼ *in.; height,* 10 *ft.* 2 *in.*

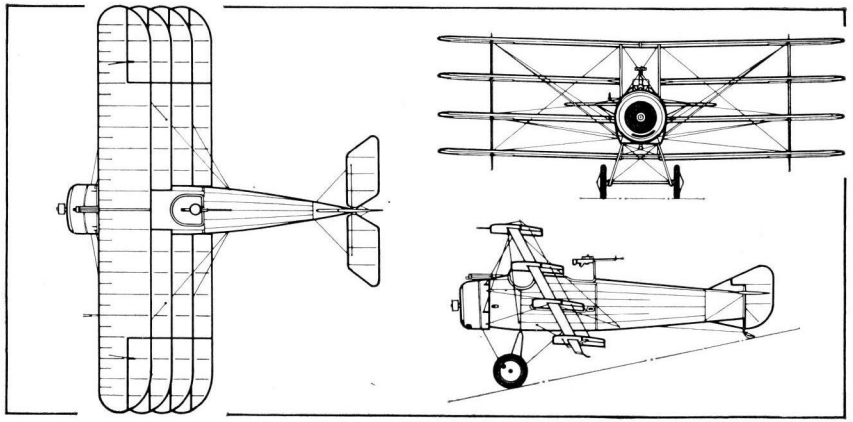
ARMSTRONG-WHITWORTH F.K.10

Frederick Koolhoven was a highly original designer who never allowed himself to be hidebound by convention or precedent. When, in 1916, he designed a two-seater that could include fighter-reconnaissance work among its duties, he chose a quadruplane configuration.

This choice may have been partly inspired by the immediate success of the Sopwith triplane; and indeed the plank-type interplane struts of Koolhoven's new design were similar to those of the Sopwith. No doubt their use was more or less inevitable, however: such struts were the best means of connecting narrow-chord wings with close-set main spars.



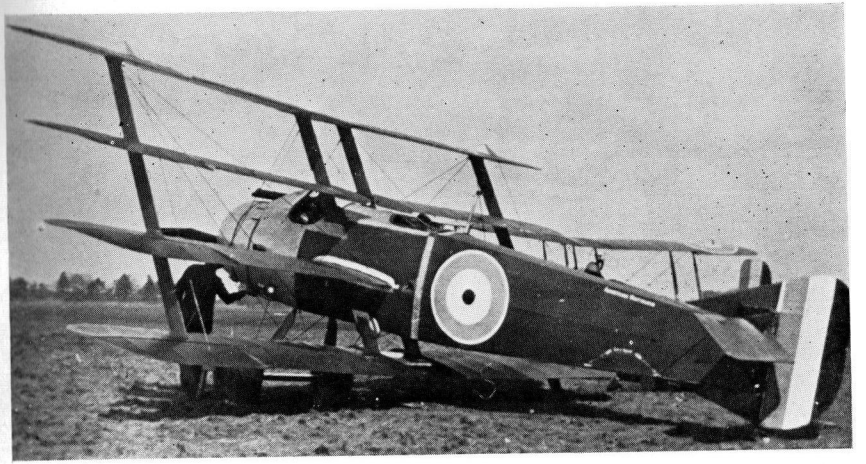
The prototype Armstrong-Whitworth F.K.10.



The Armstrong-Whitworth F.K.10 prototype had a slender fuselage, a fixed tailplane with plain elevators, and a rudder with large horn balance, but no fin above the fuselage. Its engine was a 110 h.p. Clerget rotary. This must have been the quadruplane reported to be at C.F.S. in the autumn of 1916 and tested at Martlesham in December of that year. Its top speed at 6,500 ft. was 94 m.p.h., at 10,000 ft. 87.5 m.p.h. The climb to 10,000 ft. took 23 min. 35 sec., and the service ceiling was only 13,000 ft. This performance was inferior to that of the Sopwith 1½-Strutter, which was then in service in considerable numbers.

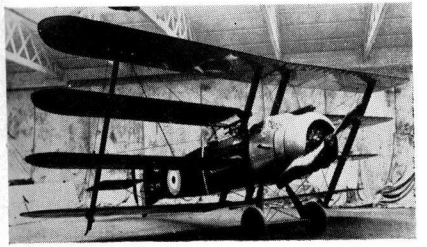
Nevertheless, a number of examples of the F.K.10 were ordered by the War Office and the Admiralty. Apparently eight were ordered for the Royal Flying Corps, three (A5212–A5214) from Armstrong-Whitworth, five (B3996–B4000) from Angus Sanderson & Co.; but it is uncertain whether all were delivered. At least three (N511, N512 and N514) were built for the R.N.A.S. by the Phoenix Dynamo Manufacturing Co.; one source also gives N513 as an F.K.10 but quotes the power unit as a 200 h.p. Sunbeam, which is scarcely possible.

The later F.K.10s differed markedly from the prototype in having a deeper fuselage of new design and a completely new tail unit. A fixed fin had been fitted above the fuselage, the shape of the rudder revised, and there was no tailplane; the balanced elevators recalled contemporary Morane-Saulnier practice. The shape of the ailerons was modified, and the chord of the lower centre section was reduced. A fixed Vickers gun was provided for the pilot, and there was a Lewis gun for the



(*Above*) *Clerget-powered F.K.10.*

(*Below*) *N511 built by Phoenix Dynamo Manufacturing Co.*

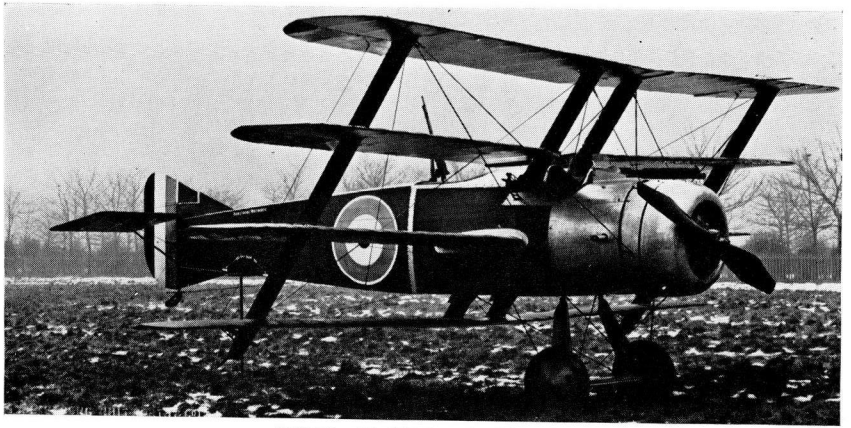


observer. On N511 the Lewis was carried on a Scarff ring mounting; the other F.K.10s had a simple pillar mounting.

Both the 110 h.p. Le Rhône and the 130 h.p. Clerget were fitted to the later F.K.10s, the latter in a horseshoe cowling. An F.K.10 with the 130 h.p. Clerget was tested at Martlesham in March 1917, when results even worse than those obtained with the 110 h.p. engine were recorded.

Of the naval F.K.10s, N511 underwent its trials at Boroughbridge on 26th April 1917. Its career was short, however: it was written off as unsafe at Manston on 21st August 1917; so too was N514.

The R.F.C. flew the type at Gosport and at C.F.S. but it was never satisfactory and was not developed.



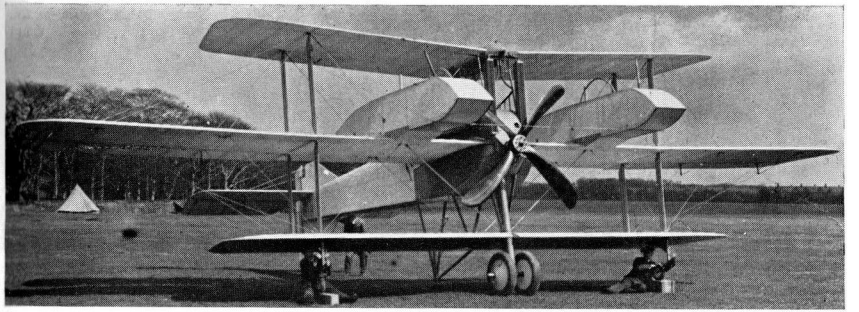
F.K.10 with 110-h.p. Le Rhône engine.

Type: *Two-seat Fighter-reconnaissance.* **Power:** *One* 110 *h.p. Clerget* 9*Z*, 130 *h.p. Clerget* 9*B*, *or* 110 *h.p. Le Rhône* 9*J nine-cylinder rotary engine.* **Armament:** *One fixed Vickers and one movable Lewis gun.* **Performance:** (130 *h.p. Clerget*): *max. speed* 84 *m.p.h. at* 6,500 *ft.*, 74 *m.p.h. at* 10,000 *ft.*, *climb to* 10,000 *ft.*, 37 *min.* 10 *sec.; service ceiling* 10,000 *ft.; endurance* 2½ *hours.* **Weights:** *Empty* 1,236 *lb., loaded* 2,019 *lb.* **Dimensions:** *Span,* 27 *ft.* 10 *in.; length,* 22 *ft.* 3 *in.; height,* 11 *ft.* 6 *in.; wing area,* 390.4 *sq. ft.*

ARMSTRONG-WHITWORTH F.K.12

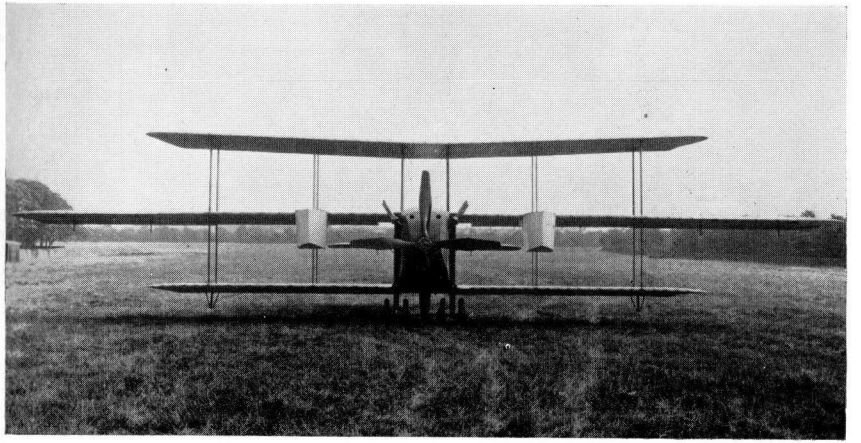
In 1916 the War Office invited British aircraft manufacturers to submit designs for multi-seat escort fighters powered by the 250 h.p. Rolls-Royce V-twelve engine; a maximum endurance of seven hours was specified. This invitation was extended at the time when the Fokker monoplane was threatening to dominate the air and the Allies still had no effective machine-gun interrupter gear.

Contracts for prototypes were awarded to Armstrong-Whitworth, Sopwith and Vickers; and all three firms produced unconventional designs. Koolhoven designed a peculiar triplane, apparently designated F.K.12, that had nacelles for two gunners attached to the upper surface of the long middle wing. The airscrew revolved a few inches ahead of the leading edge of this wing; there were two tall radiator



The first Koolhoven-designed Armstrong-Whitworth triplane.

The Armstrong-Whitworth F.K.12.

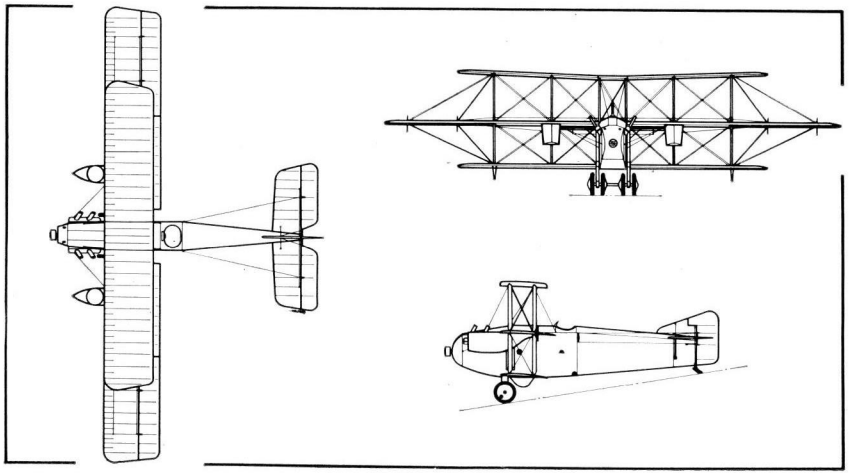


elements in the gap between the top and middle wings. The pilot sat in the fuselage, whence he could see little, for much of his field of view was blocked by the wings and the nacelles.

The undercarriage was unique. Two main wheels were mounted close together on a central sprung leg; there was a rear skid just behind the trailing edge of the bottom wing, and a small stabilizing wheel was carried under each wing tip. Flying controls were apparently conventional; the rudder was horn balanced, and only the middle wing was fitted with ailerons.

Even if the difficult ground-handling characteristics could have been mastered, it is doubtful whether the F.K.12 would have flown safely. Captain I. Fairbairn-Crawford, then general manager of the Armstrong-Whitworth aircraft department, after a heated argument with Koolhoven, refused to allow it to be flown.

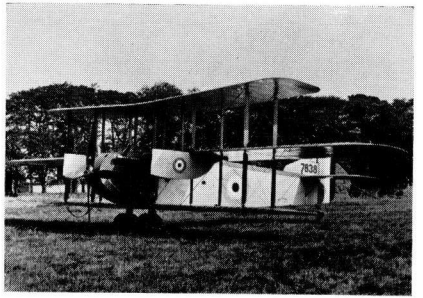
The design was completely revised and enlarged. The serial numbers 7838–7841 were allotted for four prototypes, but apparently only the first was built. (Admiralty serial numbers 3684–3685 were also allotted for prototypes of an unidentified Armstrong-Whitworth triplane that may or may not have been a version of the F.K.12. This order was cancelled, however.) It had a conventional fuselage that filled the lower gap, and the aircraft rested in a normal tail-down attitude. The four wheels of the undercarriage were mounted in pairs on two substantial oleo legs.



In general disposition the mainplanes were unchanged; they were still braced as a single-bay structure, but there were auxiliary interplane struts at the mid-bay points. The gunners' nacelles were underslung from the central mainplane.

Flight tests of the revised F.K.12 were made by Peter Legh and Lt. R. Payze. Performance was disappointing, no one liked the aircraft, and by the time it appeared gun-synchronizing mechanisms had become available. Mercifully, the F.K.12 was abandoned.

Type: *Multi-seat Escort Fighter.* **Power:** *One* 250 *h.p. Rolls-Royce twelve cylinder water-cooled engine.* **Armament:** *Two Lewis* 0.303-*in. machine-guns, one on a rocking-post mounting in each nacelle.*
Dimensions: *Span,* 62 *ft.; length,* 37 *ft.* 0¾ *in.; height,* 17 *ft.*



The F.K.12.

ARMSTRONG-WHITWORTH F.M.4 ARMADILLO

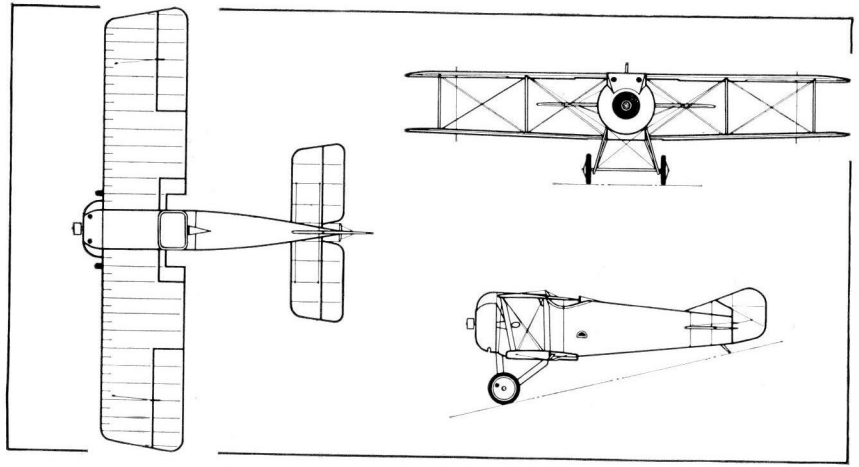
After Frederick Koolhoven left Armstrong-Whitworth to join the B.A.T. Company, F. Murphy became chief designer at Gosforth. In 1918 he designed two single-seat fighters, the first of which was the Armadillo.

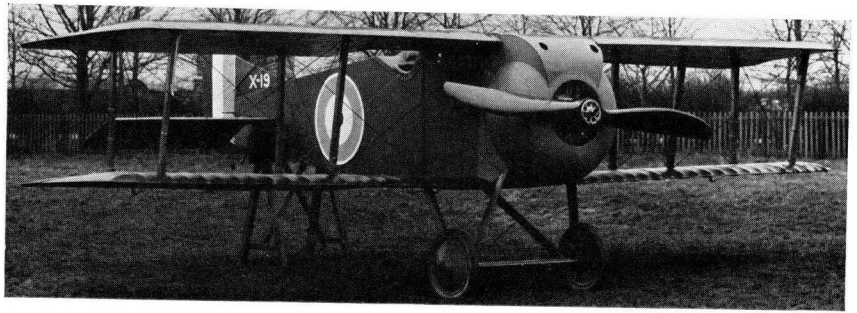
This was a stumpy little two-bay biplane in which the fuselage completely filled the gap between the wings. The twin Vickers guns were completely enclosed in a hump-like fairing above the deep engine cowling, and the pilot's view forwards and downwards must have been very poor. The engine cowling had an unusually small frontal aperture and there were no real side fairings behind it, apart from a small exhaust-deflection plate on each side.

The original conception of the design had envisaged an engine cowling of quite different form, open at the bottom and faired into the fuselage sides; this configuration would also have had a large shallow spinner on the airscrew. The early layout showed a Lewis gun mounted on the upper starboard wing root.

Structurally the Armadillo embodied some interesting features. The position and shape of the cockpit broke the continuity of the upper longerons, consequently the forward fuselage embodied duralumin girders of channel section; these girders also bore the fuel and oil tanks and the pilot's seat. In the undercarriage a departure was made from the conventional method of springing with rubber shock-absorber cord. The loops of rubber cord were within the fuselage and were connected to the axle ends by lengths of steel cable that ran over pulleys at the apices of the V-struts.

The design complied with the requirements of Air Force Type 1, and was competitive





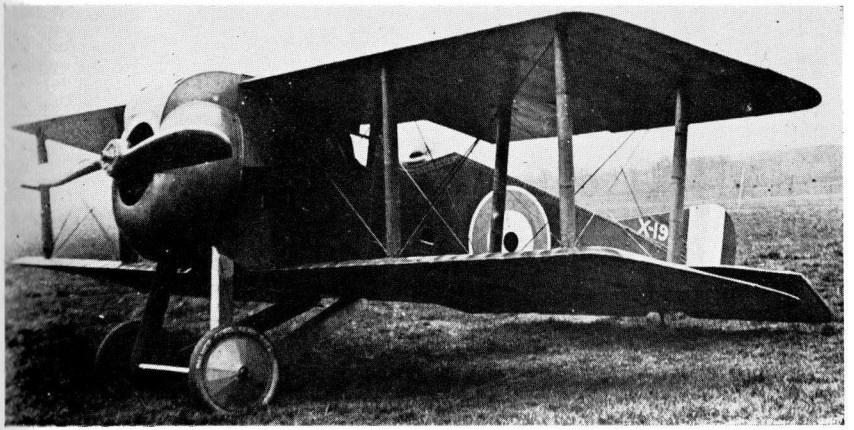
The Armadillo in its original form.

with the Sopwith Snipe and Boulton & Paul Bobolink. No official contract for prototypes was given to Armstrong-Whitworth, but an official licence (No. 18) for the construction of two aircraft was granted; the Armadillos were to be numbered X19 and X20.

Apparently only the first was built. The fuselage was erected in January 1918, and assembly of the whole aircraft was completed in March. An engine was not immediately available but one was installed by early April, when the Armadillo was test flown. During the course of these early flights a new, sturdier undercarriage was fitted and minor modifications made.

If the only available performance figures are reliable, the Armadillo had an excellent rate of climb but was somewhat slower than the Sopwith Snipe. By the time the Armadillo appeared, the Snipe was going into large-scale production. There was therefore no point in submitting the Armadillo to Martlesham Heath for official trials. The aircraft continued to be flown for a time and was seen at various aerodromes in the United Kingdom.

Type: *Single-seat Fighter.* **Power:** *One* 230 *h.p. Bentley B.R.2 nine-cylinder rotary engine.* **Armament:** *Two fixed, synchronized* 0.303-*in. Vickers machine-guns.* **Performance:** *Maximum speed* 125 *m.p.h. at ground level,* 113 *m.p.h. at* 10,000 *ft.; climb to* 10,000 *ft.,* 6 *min.* 30 *sec.; ceiling* 24,000 *ft.; endurance* 2¾ *hours.* **Weights:** *Empty,* 1,250 *lb.; loaded,* 1,860 *lb.* **Dimensions:** *Span,* 27 *ft.* 9*in.; length,* 18 *ft.* 10 *in.; height,* 7 *ft.* 10 *in.; wing area,* 232 *sq. ft.*



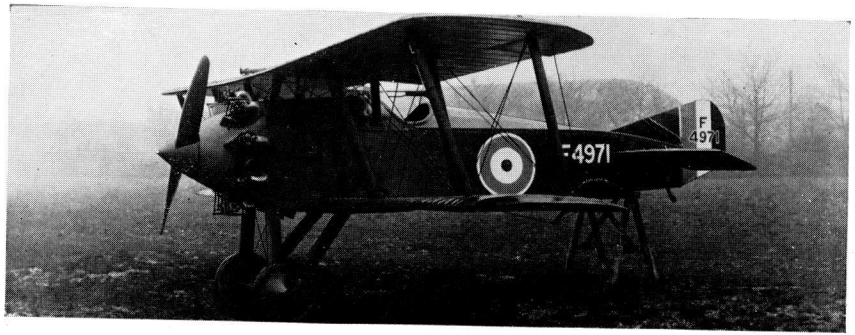
Armadillo with modified undercarriage and cut-out in fuselage side in front of cockpit.

ARMSTRONG-WHITWORTH ARA

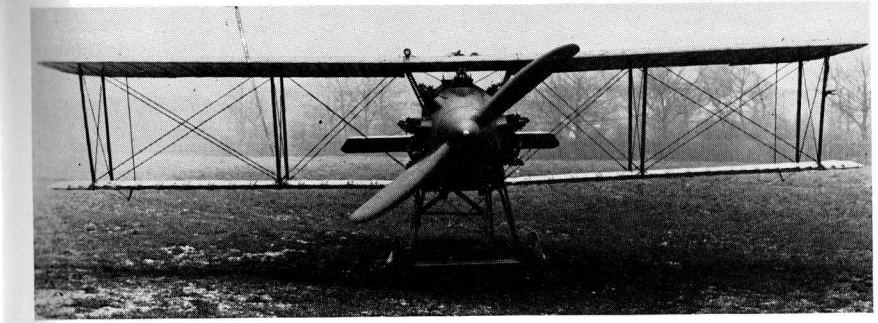
One of the many aircraft designed to exploit the promising A.B.C. Dragonfly radial engine was the Armstrong-Whitworth Ara. Like its predecessor, the Armadillo, it was a two-bay biplane with wings of unequal chord, but it had a conventional centre-section in the upper wing, which was raised above the fuselage to be level with the pilot's eyes. An unusual feature of the aircraft was its remarkably small ailerons. The two Vickers guns were mounted low down inside the cockpit, firing between the lowest pair of engine cylinders on each side. A Badin fuel system was fitted, its venturi tube being mounted on the centre section.

The fuselage had a good aerodynamic entry: there was a pointed spinner that blended cleanly with the forward fuselage contours. The tail unit was similar to that of the Armadillo. Three prototypes (F4971–F4973) were ordered.

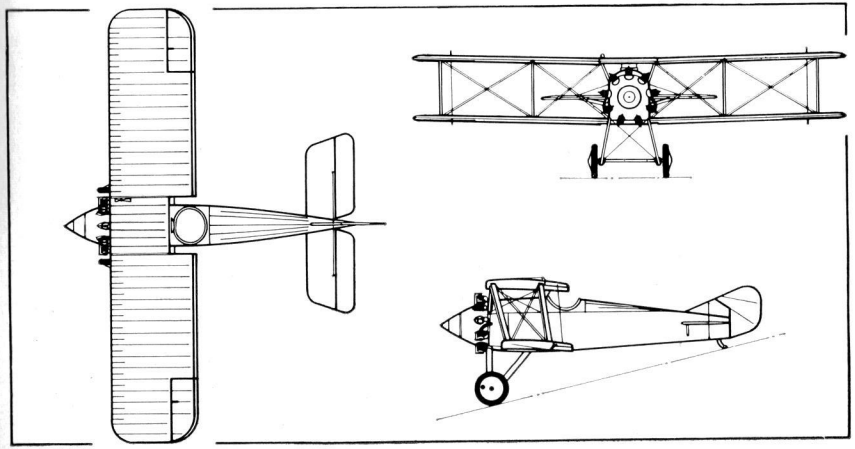
By the end of June 1918 the fuselage of the first was almost complete, the tail unit was ready for covering, and the wings and undercarriage were well advanced. Unfortunately for the Ara and its contemporaries, the Dragonfly engine had by this time begun to display symptoms of the incurable troubles that lay ahead. By the end of September 1918 only ten engines had been produced. Of the three Aras that had been ordered, the first, F4971, was complete but had been assembled with a mock-up engine. The skeleton of F4972 had been assembled and F4973 was nearing the same state. In October it was decided that the Dragonfly-powered fighters Snark, Snapper, Siskin and Ara would not go into production but that one prototype of each might be completed for trials when engines became available. This decision was later extended to the Basilisk. Each firm was given one Dragonfly engine in December 1918.



The first Ara, F4971



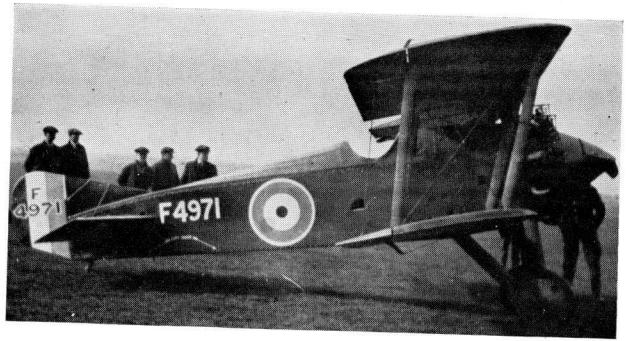
The first Ara, F4971.



The Ara's performance was excellent, but its flying must have been marred by the Dragonfly's unreliability. Owing to the complete failure of the engine, no comparative evaluation of the Dragonfly-powered fighters was made.

Some brief development of the Ara was undertaken, however. The second prototype was completed; it had increased gap, the lower wing passing under the fuselage as on the Bristol Fighter. At a later stage the first prototype had the balance area of its rudder reduced.

Late in 1919 the Armstrong-Whitworth company closed its aircraft department and all development ceased.



F4971 with modified rudder, and below, the second Ara, F4972, with increased gap.

Type: *Single-seat Fighter.* **Power:** *One 320 h.p. A.B.C. Dragonfly I nine-cylinder air-cooled radial engine.* **Armament:** *Two fixed, synchronized 0.303-in. Vickers machine-guns.* **Performance:** *Maximum speed, 150 m.p.h. at ground level; 145 m.p.h. at 10,000 ft.; climb to 10,000 ft., 4 min. 30 sec.; ceiling 28,000 ft.; endurance 3¼ hours.* **Weights:** *Empty, 1,320 lb.; loaded, 1,930 lb.* **Dimensions:** *Span, 27 ft. 5 in.; length, 20 ft. 3 in.; height, 7 ft. 10 in.; wing area, 257 sq. ft.*

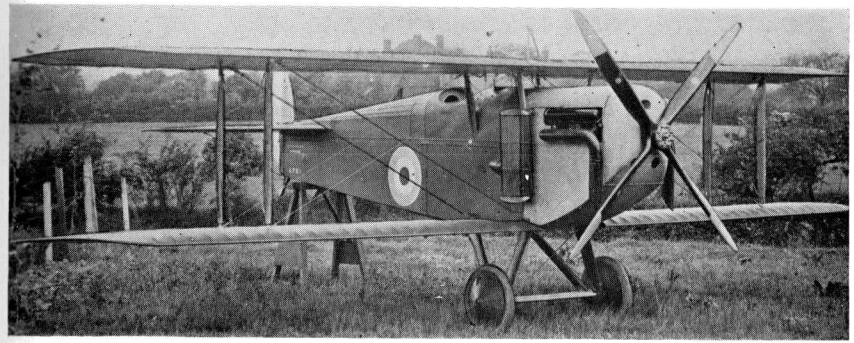
AUSTIN-BALL A.F.B.1

The precise nature of the connexion between the Austin A.F.B.1 and Captain Albert Ball, V.C., D.S.O., M.C., remains a mystery. Early in April 1916 Ball wrote home: "I have the plans now of a most wonderful machine. It will be heaps better than the Hun Fokker. I have been to the Major and he has given me full permission to fly it if I get one out."

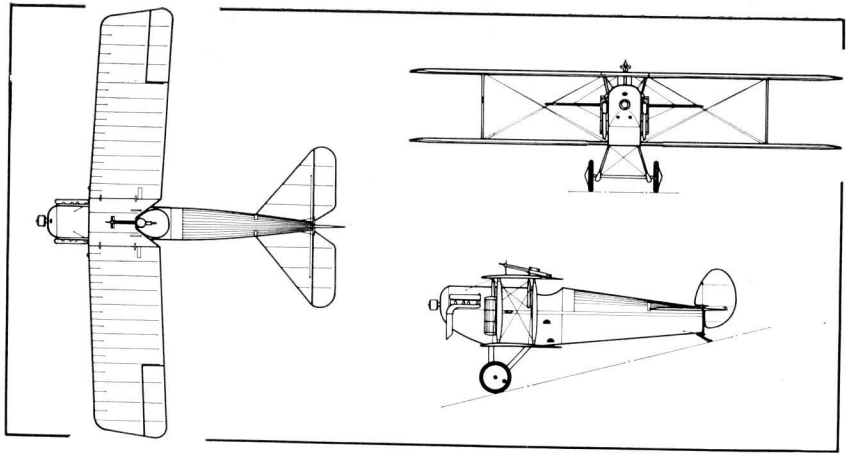
This has always been assumed to be an early reference to the Austin-Ball A.F.B.1, but when Ball wrote his letter he was an unknown pilot in a B.E.2c squadron, had flown nothing but two-seaters, and had shot down no enemy aircraft. Moreover, the first Hispano-Suiza engines to be delivered against a British order were not supplied until August 1916, and it is unlikely that Ball could have had an opportunity to study an example in the six or seven weeks he had then spent in France. Hence, while it is possible that the aircraft Ball had in mind when he wrote his letter may have been a single-seat fighter, it could scarcely have been the Austin-Ball A.F.B.1 that was built in 1917.

The A.F.B.1 was obviously designed from the start to have a Hispano-Suiza engine and was not a re-hash of anything that might have been designed to have a different power unit.

It therefore seems probable that there was no connexion between the unknown aircraft of which Ball had drawings in early 1916 and the A.F.B.1, and that the A.F.B.1 itself dated from late 1916. By that time Ball had become well-known as an experienced fighter pilot; his views carried authority and his opinions on fighting aircraft were likely to be sought and respected. It is known that Ball visited the Austin works in December 1916; and in his



Austin-Ball A.F.B.1 with single-bay wings.



book *Captain Albert Ball, V.C., D.S.O.*, R. H. Kiernan states: "A group of business men interested in founding an aeroplane concern offered Ball a place on the Directorate, on condition that he would resign from the R.F.C., or ask release from service, and pressed on him a retaining fee of £1,000. But Ball made it clear to them that he could not join while there remained work for him in France, and the money was still untouched in his bank when he was killed."

These scanty and not necessarily related facts could be taken to suggest that Ball acted in an advisory capacity to the designer of the A.F.B.1, most probably on such matters as the pilot's position in the aircraft, view from the cockpit, and the arrangement of the armament. It is certainly difficult to believe that he did more than this. On 9th February 1917 he wrote to his father: "I told Austins I was surprised at them calling the machine the Austin, and forgetting me. Also I stated it was to be called the A.B. or Austin Ball." Even if one makes allowance for Ball's modesty, this hardly sounds like the kind of thing that would be written by the man who designed the A.F.B.1, but it does suggest that Austins regarded the design as theirs.

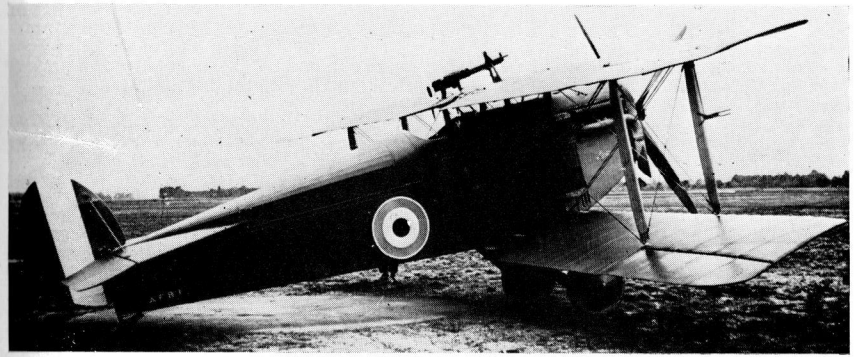
Kiernan records how Ball, in London, met a representative of the Austin firm who had failed to secure official interest in the aircraft. Thereupon Ball went personally to the Air Board and received from Brigadier-General Sefton Brancker an order for two prototypes, "with the promise that if they were ready to time and successful, there would be a larger order."

This seems to confirm that the A.F.B.1 had been designed as a private venture.

It was, for 1917, an unusually clean and compact aircraft. Its deep fuselage filled most of the interplane gap, and the pilot sat with his eyes level with the upper wing. The first version of the A.F.B.1 had single-bay wings of equal span; they had neither dihedral nor stagger, but were swept back slightly. Cut-outs in the lower wing roots improved the pilot's downward view. Ailerons were fitted to upper and lower mainplanes; they were actuated by internal spanwise rods and needed no external cables or control horns; there was not even a cable connecting upper and lower surfaces. Similarly, all control runs to the tail unit were carried internally.

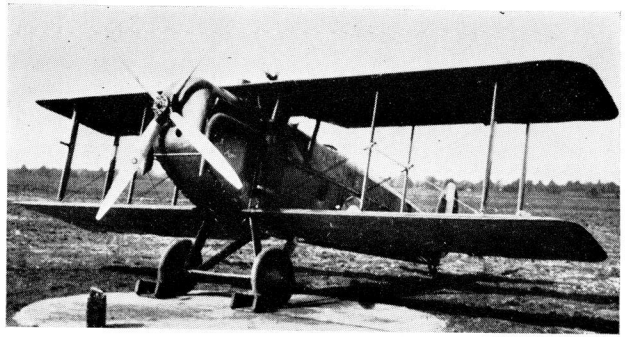
Armament consisted of two Lewis guns. One was installed as a fixed gun: it occupied a central position in the cockpit and fired forward through the hollow airscrew shaft. This was possible because the engine was a 200 h.p. Hispano-Suiza with reduction gearing, and minor modifications to the induction manifold system permitted a gun to fire between the cylinder blocks. The second gun of the A.F.B.1 was on a Foster mounting above the centre section; it was intended for upwards firing only, in the manner employed so successfully by Ball.

In its basic construction the Austin-Ball Scout was conventional, having a wooden airframe, wire-braced and fabric-covered. Workmanship and finish were excellent and great attention had been paid to detail design. Metal fittings were simplified as much as possible; they could be removed without dismantling any of the structure. The engine was cowled in an unusual manner, and there were



The A.F.B.1 at Martlesham.

A.F.B.1 with straight wings and Spad-type interplane bracing, at Martlesham Heath.



two side-mounted radiator blocks. A by-pass in the cooling system enabled one block to be cut off in the event of damage.

The A.F.B.1 was tested at Martlesham Heath in July 1917, two months after Ball's death. With its Grahame-White four-blade airscrew it had, overall, a slightly better performance than the S.E.5a with 200 h.p. Hispano-Suiza. It was reported to be comfortable to handle, but it was considered that the lateral control could be better. While at Martlesham the A.F.B.1 was subjected to comparative trials with two other airscrews of smaller diameter and coarser pitch; these were of Tibbenham and Vickers design. In each case the performance was somewhat inferior to that obtained with the Grahame-White airscrew, the blades of which were of unusually high aspect ratio.

Good though it was, the A.F.B.1 did not go into production. The S.E.5a was in large-scale production and it was rightly decided not to interfere with its manufacture. Development of the Austin-Ball Scout did not cease immediately, however, for a second version of the design was tested at Martlesham. This had wings without sweepback: the interplane rigging was in principle identical with that of the Spad S.7 and gave the aircraft the appearance of a two-bay biplane. The wing tips were square cut, and there appeared to be a gravity petrol tank in the centre section.

Type: *Single-seat Fighter.* **Power:** *One 200 h.p. Hispano-Suiza eight-cylinder water-cooled engine.* **Armament:** *Two 0.303 in. Lewis machine-guns, one firing through the hollow airscrew shaft, the other on a Foster mounting above the centre section.* **Performance** (*original form*): *Maximum speed 138 m.p.h. at ground level, 126.5 m.p.h. at 10,000 ft., 120.5 m.p.h. at 15,000 ft. Climb to 10,000 ft., 8 min. 55 sec.; to 15,000 ft. 16 min. 15 sec. Service ceiling, 22,000 ft. Endurance, 2¼ hours.* **Weights** (*original form*): *Empty, 1,525 lb.; loaded, 2,077 lb.* **Dimensions** (*original form*): *Span, 30 ft.; length, 21 ft. 6 in.; height, 9 ft. 3 in.; wing area, 290 sq. ft.*

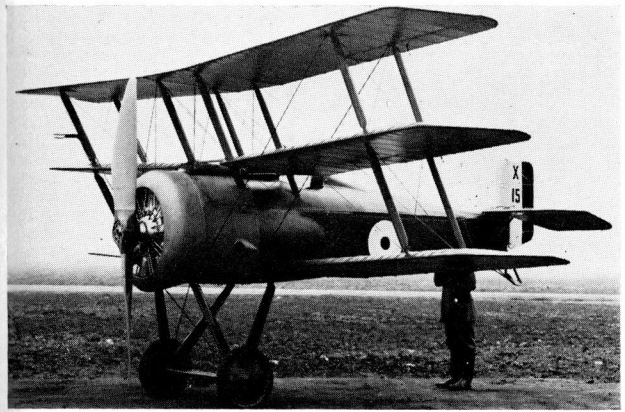
AUSTIN A.F.T.3 OSPREY

Like the Armstrong Whitworth Armadillo, Boulton and Paul Bobolink, and Nieuport B.N.1, the Austin A.F.T.3 Osprey was designed to be competitive with the Sopwith Snipe. Like the Armadillo, the Osprey was a private venture; official Licence No. 17 permitted the construction of three prototypes, numbered X15–X17.

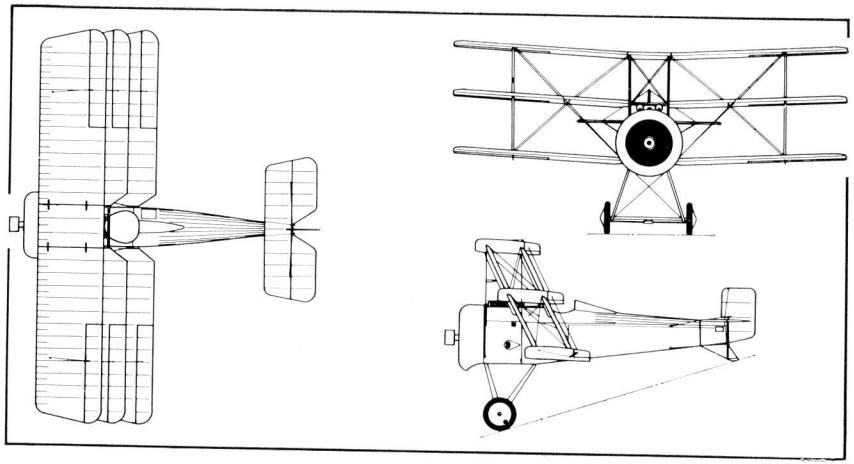
It was a small, stumpy triplane, the corpulence of its fuselage being dictated by the diameter of the 230 h.p. Bentley B.R.2 engine. The tall undercarriage necessitated by the large-diameter airscrew gave the A.F.T.3 a considerable ground angle; this was partly offset by the high tail-skid.

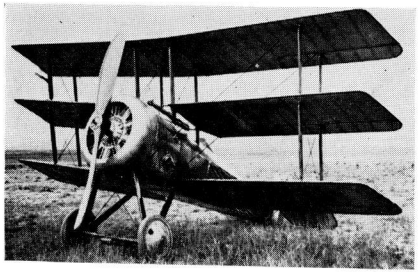
The Osprey had a conventional wooden airframe, wire-braced and fabric-covered; it was characterized by good detail design and was intended to be easy to produce and maintain. The number of metal fittings in the fuselage was kept to a minimum, and any longeron could be replaced without disturbing the fuselage bracing. All mainplanes and ailerons on each side were basically interchangeable but in reality had differences of detail: the middle and bottom wings had a small part of the root trailing portion cut away to improve the pilot's view, and a triangular aileron-pulley inspection window was let into the underside of each top wing. The undercarriage was sprung in an unusual manner: there was a single shock-absorber at the centre of the spreader bars, connected by cables to the ends of the axle. Several details were reminiscent of the S.E.5a, for which the Austin company were contractors.

In conformity with the requirements of Air Board specification Type A.1(a) the Osprey's armament consisted of two synchronized Vickers guns and a movable Lewis gun. The latter could have found only limited use on the Osprey, for it was mounted on the rear spar of the centre-section framework of the middle wing and its field of fire was considerably restricted. A dummy Lewis was fitted for the aircraft's trials at Martlesham Heath.



Austin A.F.T.3 Osprey shortly after completion.



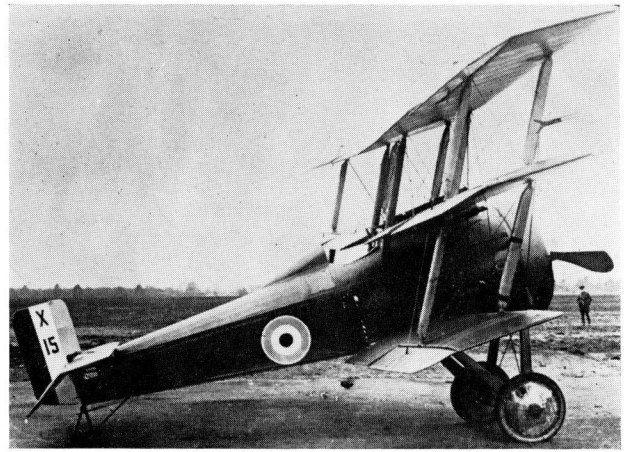


The Osprey at Farnborough, 17th June 1918.

The B.R.2 engine (No. E.X.3) for X15 was delivered in January 1918 and the aircraft made its first flights at Castle Bromwich in the following month. The Osprey was then flown to Martlesham Heath, where the official trials were carried out in March 1918, at a loaded weight that exceeded the original estimate by 175 lb. The performance of the Austin triplane was good but still somewhat inferior to that of the Sopwith Snipe. The Osprey suffered from the further disadvantage that its triplane configuration made rigging more complicated than that of a biplane. It did not go into production, and the second and third prototypes, although reported to be in an advanced stage of construction, were abandoned in March 1918. The prototype X15 continued to be flown

during the summer of 1918. On 22nd May 1918 Captain Plaistowe flew it from Martlesham to Farnborough, where it remained at least until 15th June.

The Osprey made few recorded flights at the R.A.E. and apparently was not flown for any specific experimental purpose. While at Farnborough it was flown by Captain J. Palethorpe and Captain J. Noakes.



The Osprey at Martlesham Heath.

Type: *Single-seat Fighter.* **Power:** *One* 230 *h.p. Bentley B.R.2 nine-cylinder rotary engine.* **Armament:** *Two fixed synchronized* 0.303-*in. Vickers machine-guns; one semi-free* 0.303-*in. Lewis machine-gun on the rear spanwise member of the middle centre section.* **Performance:** *Maximum speed* 118.5 *m.p.h. at* 10,000 *ft.*, 110.5 *m.p.h. at* 15,000 *ft.*; *climb to* 10,000 *ft.*, 10 *min.* 20 *sec.*; *to* 15,000 *ft.*, 21 *min.* 20 *sec.*; *service ceiling*, 19,000 *ft.*; *endurance*, 3 *hours at* 15,000 *ft.* **Weights:** *Empty*, 1,106 *lb.*; *loaded*, 1,888 *lb.* **Dimensions:** *Span*, 23 *ft.*; *length*, 17 *ft.* 7 *in.*; *height*, 10 *ft.* 8 *in.*; *wing area*, 233 *sq. ft.*

AUSTIN GREYHOUND

The A.B.C. Dragonfly engine seemed to be so promising that it was a natural choice as the power unit of a replacement for the redoubtable Bristol Fighter. Four manufacturers submitted designs for consideration in the R.A.F. Type III category: contracts were given to Austin, Bristol and Westland; a recommendation was made that the Whitehead company should be granted a licence for the construction of two prototypes. The Whitehead design came to nothing; the others emerged as the Greyhound, Badger and Weasel respectively.

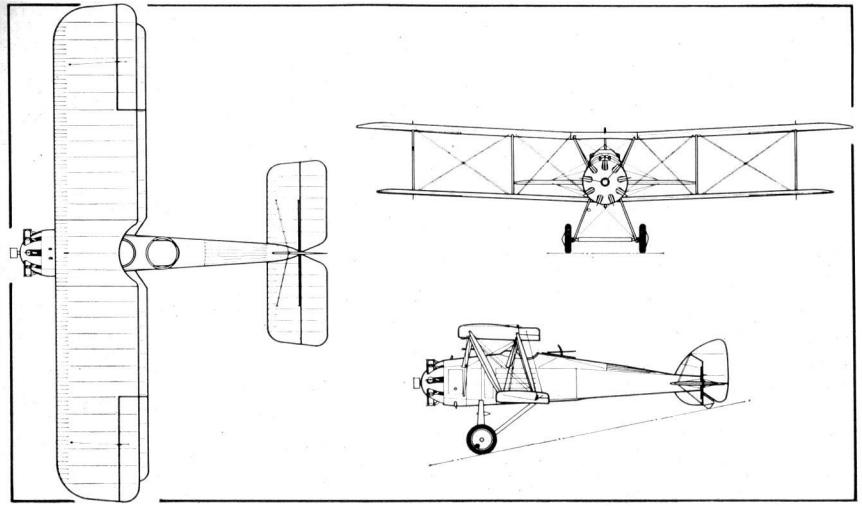
The first Greyhound.

The Austin Greyhound was a handsome two-bay biplane designed by J. Kenworthy, who had been a member of the design staff of the Royal Aircraft Factory. Traces of some Factory influence could be seen in the Greyhound: the outline of the fin and rudder generally resembled that originally designed for the S.E.5 and that of the Maori-powered R.E.9.

For its time, the Greyhound was well equipped. The pilot had twin fixed Vickers guns, and the observer had a Lewis gun on a Scarff ring-mounting; 1,700 rounds of ammunition were carried. The increased combat altitudes of 1918 demanded the provision of oxygen equipment and electrical heating apparatus; and a camera and wireless were also carried. Dual control was provided.

Structurally, the Greyhound was conventional, its only unusual feature being the unequal chord and span of the wings. Pilot and observer were placed close together for ease of communication, and the shape of the rear fuselage gave the observer an excellent field of fire.

Construction of the first prototype, H4317, was under way in June 1918, but owing to delay caused by the troubles of the Dragonfly engine the aircraft was not completed until after the Armistice. The first prototype was flown to Martlesham Heath on 15th May, 1919. The official test report on the type (No. M.261) was not prepared until August 1919, a fact that suggests that troubles, possibly with the Dragonfly, were experienced. Performance



The third Greyhound, H4319.

proved to be quite good but, like all Dragonfly-powered aircraft, the Greyhound was doomed by the failure of its engine.

The third aircraft, H4319, had a fin and rudder of slightly different outline and a modified fuel system. The cowling about its engine was also modified, presumably to improve cooling.

In January 1919 the Austin company proposed a single-seat mail-carrying conversion of the Greyhound. The pilot's cockpit was moved aft to make way for a mail compartment, and the lines of the fuselage were considerably cleaned up. With fuel capacity increased to 91 gallons it was envisaged that the Greyhound would be able to fly non-stop from London to Glasgow with 400 lb. of mail, making intermediate drops at Newcastle and Edinburgh. This project came to nothing, however, and no development of the basic design was made.

Of the three Greyhounds, it is known that the second aircraft, H4318, survived at least until June 1922. In that month it was still flying at the Royal Aircraft Establishment, Farnborough, apparently being used to test such things as fuel supply equipment. Its last recorded flight at the R.A.E. was made on 12th June 1922.

The first Greyhound at Martlesham Heath.

Type: *Two-seat Fighter-reconnaissance.* **Power:** *One* 320 *h.p. A.B.C. Dragonfly I nine-cylinder air-cooled radial engine.* **Armament:** *Two fixed, synchronized* 0.303-*in. Vickers machine-guns firing forward, one* 0.303-*in. Lewis machine-gun on a Scarff ring mounting on rear cockpit.* **Performance:** *Maximum speed* 129 *m.p.h. at* 6,500 *ft.,* 126 *m.p.h. at* 10,000 *ft.,* 121 *m.p.h. at* 15,000 *ft.; climb to* 10,000 *ft.,* 10 *min.* 50 *sec.; to* 15,000 *ft.,* 19 *min.* 40 *sec.; service ceiling,* 19,000 *ft.; endurance,* 3 *hours.* **Weights:** *Empty,* 1,838 *lb.; loaded,* 3,032 *lb.* **Dimensions:** *Span, upper* 39 *ft., lower* 36 *ft.* 7 *in.; length,* 26 *ft.* 8½ *in.; height,* 10 *ft.* 4 *in.; wing area,* 400 *sq. ft.*

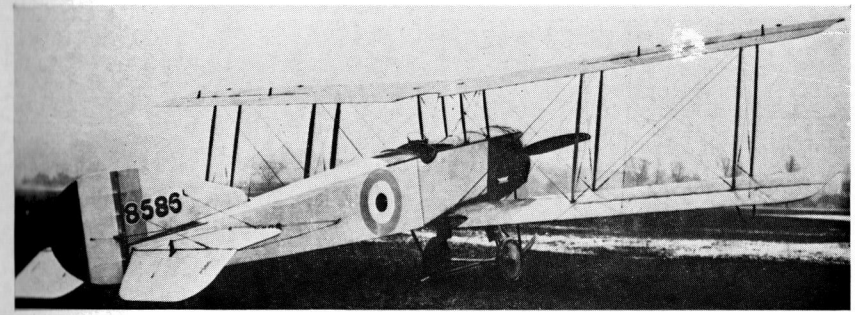
AVRO 504C, D, F & K

In the early months of the war, the Avro 504 two-seaters of the R.F.C. and R.N.A.S. had, like their contemporaries, to perform various duties. One of the earliest attempts to use the Avro 504 as a fighter was made by 2nd Lt. L. A. Strange of No. 5 Squadron, R.F.C., who, in October 1914, installed a Lewis gun for the use of the observer on Avro No. 383.

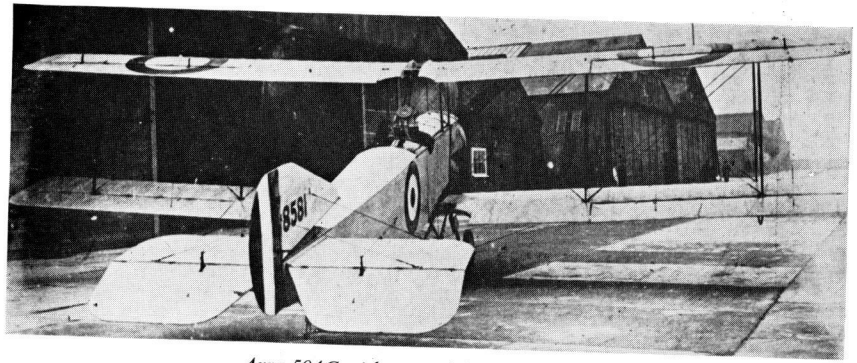
The R.N.A.S. used the 504 as an anti-Zeppelin aircraft. On 17th May 1915, Flight Sub-Lt. R. H. Mulock intercepted the L.Z.38 but could not match the airship's rate of climb; and Flight Commander A. W. Bigsworth, flying No. 1009, attacked L.Z.39 over Ostend.

Anti-airship work called for a substantial flight endurance. This requirement produced the Avro 504C, a single-seater in which a large petrol tank filled the space normally occupied by the observer. It appears that the modifications were designed in May 1915. The airframe was essentially that of the 504B: the plain rudder, large fin and long ailerons that characterized R.N.A.S. sub-types of the 504 were fitted; the cockpit sides were cut lower than the line of the upper longerons; the mainplanes had Admiralty-size spars and quadrantal cut-outs at the roots of the lower wings.

In all, eighty 504Cs were ordered, fifty (1467–1496 and 3301–3320) from the Brush Electrical Engineering Co. of Loughborough, the remainder (8574–8603) from the parent firm. The aircraft were used at R.N.A.S. stations at Great Yarmouth, East Fortune, Redcar, Westgate, Dunkerque, Dover, Felixstowe, Hendon, Chingford, Eastchurch and Cranwell. It is probable that some of them were converted into two-seaters for training purposes. In a few instances the reverse happened with some 504Bs, such as No. 1043, which was used



Standard Avro 504C built by A. V. Roe & Co.



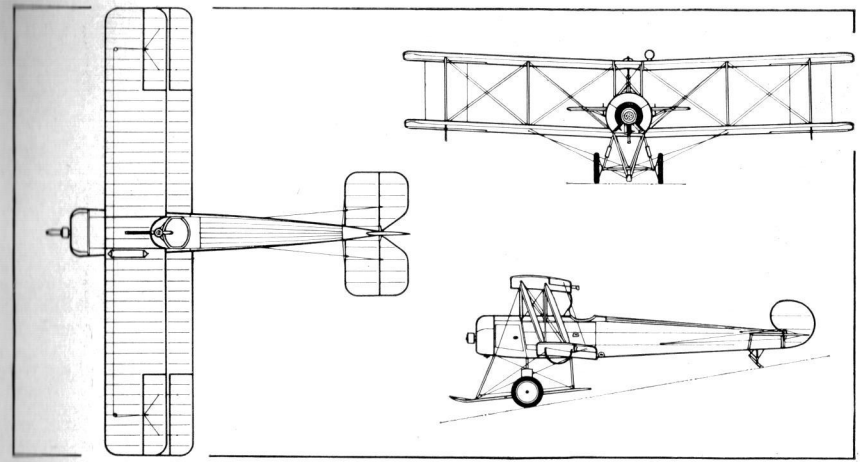
Avro 504C with upward-firing Lewis gun.

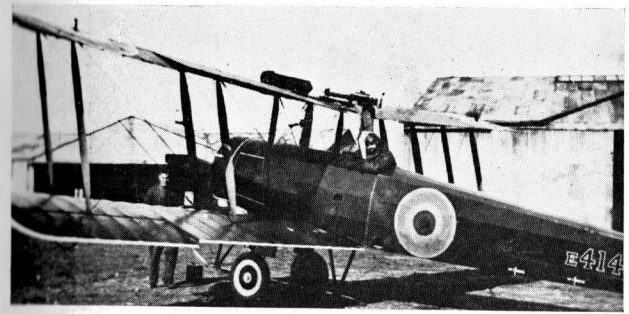
by No. 2 Wing, R.N.A.S., in the Aegean; it had its forward cockpit faired over and was indistinguishable from a 504C.

Installation of 80-h.p. Gnôme in Avro 504D.

One 504C, No. 8603, was modified in 1916. It was fitted with a 75 h.p. Rolls-Royce Hawk engine, a six-cylinder in-line unit, and received the new designation Avro 504F. The 504F went to Eastchurch for trial in July 1916, and an order for thirty production aircraft was given to an Admiralty contractor. This was subsequently cancelled and replaced by a contract for the standard 80 h.p. Gnôme Avro.

For the R.F.C. a single-seat variant of the Avro 504 was built under the designation 504D. Only six (794–799) were delivered in August 1915. Photographic evidence is scanty, but it seems that the 504D had the cockpit sides cut low, as on the 504C; in all other details the 504D was a typical R.F.C. Avro, having the original balanced rudder and short-span ailerons. The operational use of the sub-type is obscure, but it is known that No. 794 was on the strength of No. 12 Squadron, R.F.C., in August and September 1915.





Humber-built single-seat fighter conversion of the Avro 504K.

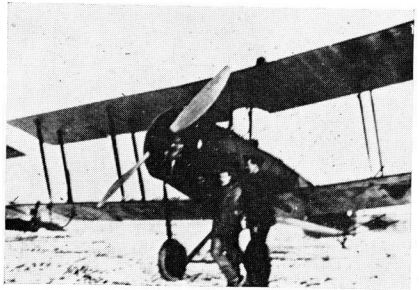
Early in 1918 it was decided that Home Defence squadrons in the northern area must have aircraft with a useful operational ceiling. First-line fighters could not be spared, so the squadrons

were equipped with single-seat conversions of the Avro 504K, powered by the 110 h.p. Le Rhône engine, which could reach 18,000 ft. These single-seat 504Ks resembled the 504C and 504D in having the front cockpit faired over.

The armament consisted of a single Lewis gun on a Foster mounting carried centrally above the centre section; the cylindrical gravity tank was moved outboard on to the port upper wing to make way for the gun. A wind-driven generator was mounted on the lower starboard wing root. Several of these Home Defence Avros were later fitted with a V-type undercarriage generally similar to that of the Avro 521.

Six Home Defence squadrons used the Avro 504K; five were still equipped with the type at the time of the Armistice. Had the war lasted a few weeks longer the Avros would have been replaced by Camels.

Parnall-built Avro 504K single-seat fighters of No. 77 Squadron, Penston, East Lothian.



Avro 504K night fighter with V-strut undercarriage.

Type: *Single-seat Fighter.* **Power:** 504*C and* 504*D, one* 80 *h.p. Gnôme seven-cylinder rotary engine;* 504*F,* 75 *h.p. Rolls-Royce Hawk six-cylinder water-cooled engine;* 504*K,* 110 *h.p. Le Rhône* 9*J nine-cylinder rotary engine.* **Armament:** *One* 0.303 *Lewis machine gun; in the* 504*K, fitted with Hutton illuminated sight and carried on Foster mounting.* **Performance:** *The standard two-seat* 504*K with* 110 *h.p. Le Rhône could do* 95 *m.p.h. at ground level,* 85 *m.p.h. at* 10,000 *ft.; it could climb to* 10,000 *ft. in* 16 *min. Performance of the Home Defence single-seat version would be comparable. The* 504*C and* 504*D had a flight endurance of* 8 *hours.* **Weights:** *No details available.* **Dimensions:** *Span,* 36 *ft.; length,* 29 *ft.* 5*in.; height,* 10 *ft.* 5 *in.; wing area,* 330 *sq. ft.*

AVRO 521

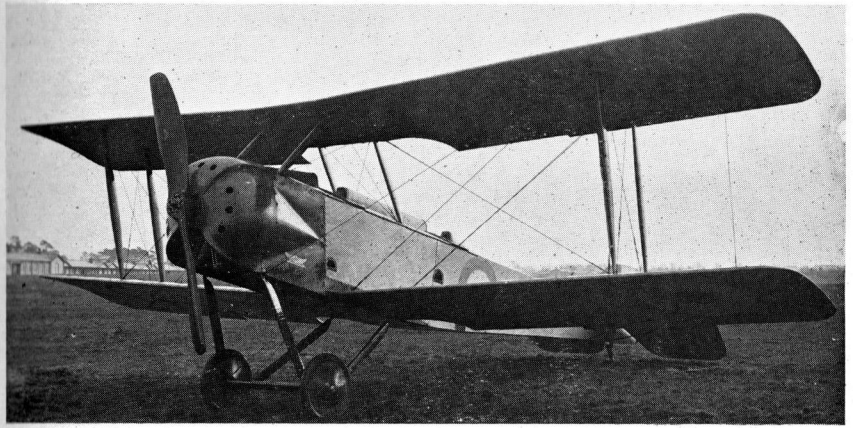
The Avro 521 was a two-seat fighter that bore a family resemblance to the Avro 504. It was designed in 1915 and the prototype was completed towards the end of that year.

Apparently three versions were designed: the 521 with single-bay wings of 30 ft. span, the 521A with wings of 42-ft. span, and the 521B with standard 36-ft. span Avro 504 wings and two-bay bracing. Drawings assumed to be of the 521B depict the aircraft with the fin and plain rudder that usually denoted an Admiralty Avro.

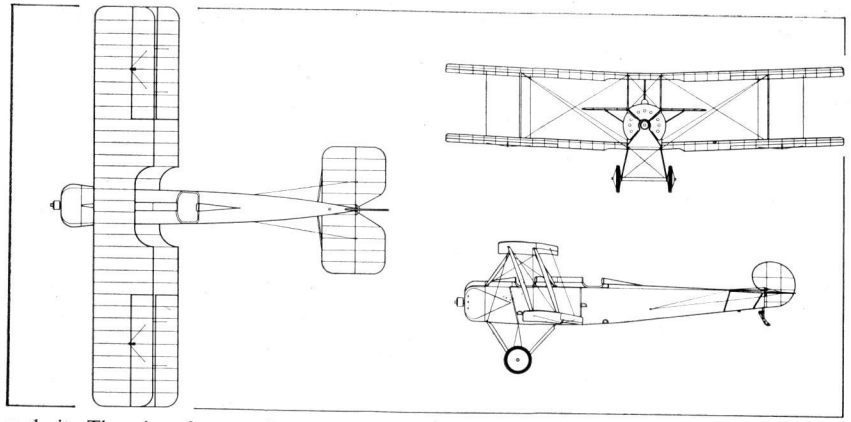
Only the single-bay version was built. Originally it bore the serial number 1811 on its fuselage, but this had been removed by February 1916, doubtless because it had by then been realised that that number had already been allotted to a Blériot monoplane.

The cockpits were widely separated, the upper longerons were straight throughout their length, the centre-section struts diverged markedly to meet the fuselage, and a V-type undercarriage was fitted. The tailplane and elevators appeared to be standard Avro 504 components, and 504 ribs may have been used in the Avro 521 mainplanes, for on both types the chord was 4 ft. 9¾ in.

The initial tests of the Avro 521 were flown at Trafford Park, Manchester, by F. P. Raynham with H. E. Broadsmith in the rear

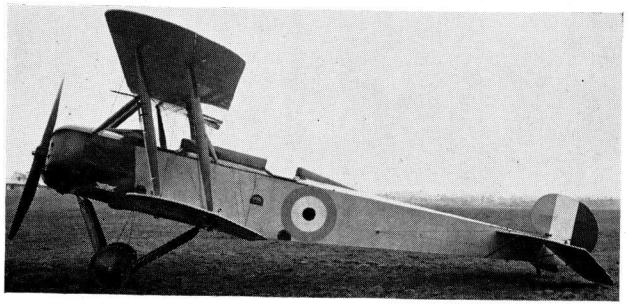


The prototype Avro 521 at Farnborough.



cockpit. The aircraft proved to have rather unpleasant handling characteristics, but it was sent to Farnborough, presumably for official trials, in January 1916; its presence there, as the "Avro Scout 1811", was recorded on 20th January.

Serial numbers (7520–7544) were allotted for 25 production aircraft, but it is doubtful whether any was completed. The prototype went to Central Flying School, Upavon. It crashed there on 21st September 1916, killing its pilot, Lt. W. H. S. Garnett.



Avro 521.

General-arrangement drawings dated July 1916 show an Admiralty-type fin on an Avro 521 with reduced gap; the rear cockpit has modified contours and a free-mounted Lewis gun is depicted; there are no windscreen-cum-headrest fairings at the cockpits. It seems unlikely that this variant was built.

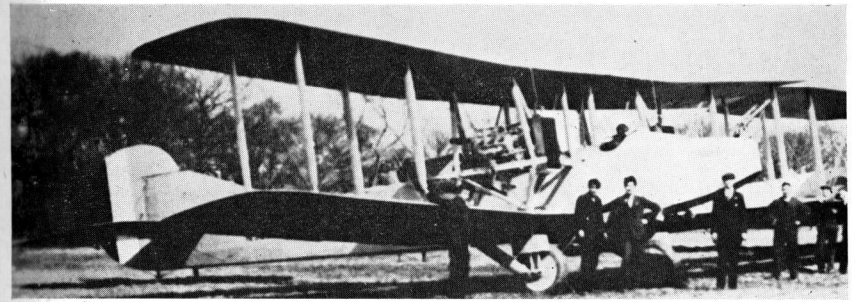
Type: *Two-seat Fighter.* **Power:** *One* 110 *h.p. Clerget 9Z nine-cylinder rotary engine.* **Armament:** *One* 0.303 *Lewis machine-gun on movable mounting on rear cockpit.* **Performance:** *No details available.* **Weights:** *Empty,* 1,150 *lb., loaded* 1,995 *lb.* **Dimensions:** *Span,* 30 *ft.; length,* 28 *ft.* 2 *in.; wing area* 266 *sq. ft.*

AVRO 523 PIKE

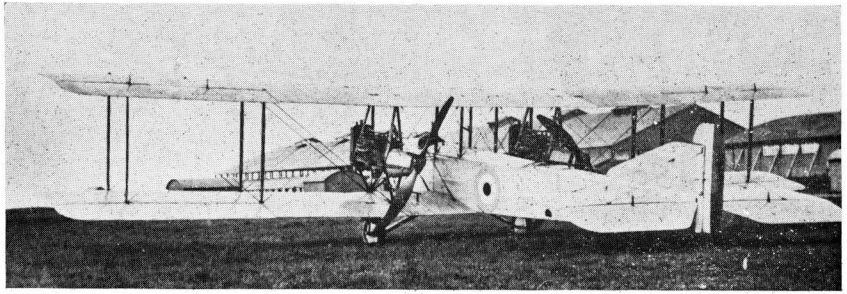
The Avro 523 was a three-seat twin-engine biplane, apparently designed to meet an Admiralty requirement for a long-range anti-Zeppelin or escort fighter. The design dated from October 1915, and was the first twin-engine Avro type.

Construction was undertaken at the Manchester works of A. V. Roe & Co. Ltd., final assembly being done at Hamble. The Pike emerged as a handsome, well-proportioned biplane powered by two 150 h.p. Sunbeam engines; these drove opposite-handed pusher airscrews via extension shafts. The airframe was a typical wooden structure, wire-braced and fabric-covered. The undercarriage was a sturdy, divided-axle structure in which the forward leg of each V-strut embodied a shock absorber that was similar in principle to those of the Avro 504.

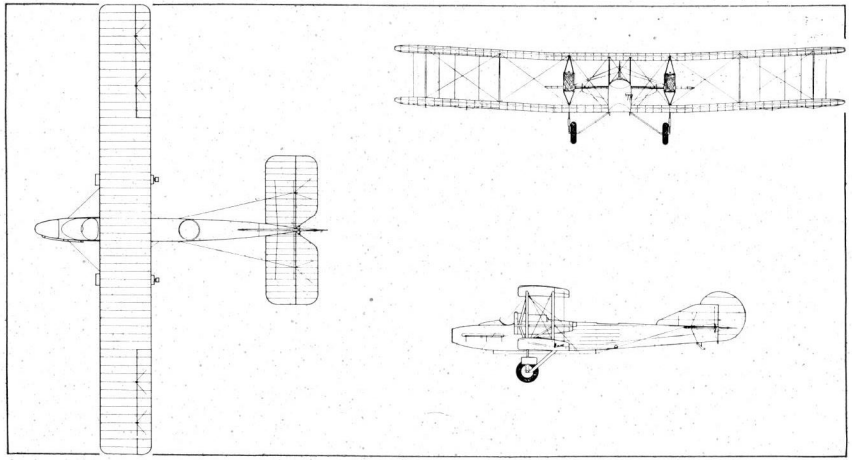
The pilot sat just forward of the wing leading edges; a short distance in front of him was the front gunner's cockpit, on which a large-calibre quick-firing gun could be mounted. The rear gunner was situated well aft, midway between the wings and the tail; emergency dual controls were installed in his cockpit. Two

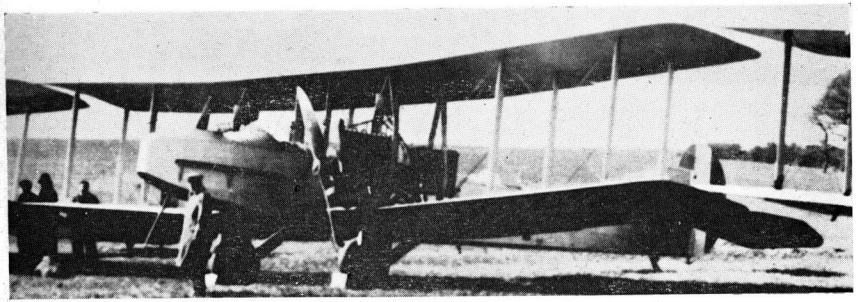


The first Pike with quick-firing gun on front cockpit.



The first Pike with modified rudder at the Isle of Grain





The second Pike with Green engines.

forward-looking electric lamps were mounted under the lower longerons just ahead of the wings, indicating that the Pike was intended to be a night-flying aircraft.

First flight tests were made in May 1916, and the Pike proved to have a good performance. On one flight, while being piloted by F. P. Raynham with R. H. (now Sir Roy) Dobson as passenger, the aircraft displayed serious tail-heaviness. It was saved from an untimely end by the young Roy Dobson's perilous climb forward to the bow cockpit, where his weight made the aircraft sufficiently controllable for Raynham to bring it down safely.

The Pike was flown at the Isle of Grain. By the time it had reached there it had been fitted with a new rudder that had reduced chord and a straight trailing edge.

A second aircraft was built, apparently designated 523A. This machine had two 150 h.p. Green engines driving tractor airscrews, and the front gunner's cockpit was built up to support a Scarff-type ring mounting for a Lewis gun. It was tested in August 1916. Apparently two developments were projected: the Avro 523B with two Sunbeams and the 523C with two Rolls-Royce engines, presumably Falcons. Neither was built but it is probable that the 523C may have provided the basis for the design of the Avro 529.

Both the 523 and 523A were still in existence in April 1917, but the former was written off on 26th May 1917.

Type: *Multi-seat Fighter.* **Power:** *Two* 150 *h.p. Sunbeam eight-cylinder water-cooled engines* (*pushers*); *two* 150 *h.p. Green six-cylinder water-cooled engines* (*tractors*). **Armament:** *One quick-firing gun on front cockpit; one* 0.303 *in. Lewis machine gun on movable mounting on rear cockpit.* **Performance:** *Maximum speed* 97 *m.p.h. at ground level*; 88 *m.p.h. at* 10,000 *ft. Climb to* 5,000 *ft.*, 9 *min.* 30 *sec.*; *to* 10,000 *ft.*, 27 *min. Endurance*, 7 *hours.* **Weights:** *Empty*, 4,000 *lb.*; *loaded*, 6,064 *lb.* **Dimensions:** *Span*, 60 *ft.*; *length*, 39 *ft.* 1 *in.*; *wing area*, 815 *sq. ft.*

AVRO 527

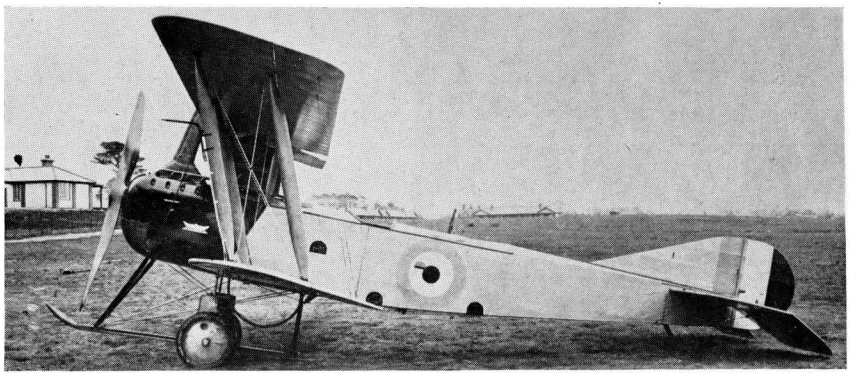
In the course of a lecture, *The History and Evolution of the Avro Training Machine*, delivered to the Institution of Aeronautical Engineers on 9th January 1925, Mr. R. J. Parrott said:

"We made a final effort to resurrect it [the Avro 504] as a fighter by fitting a 150 h.p. Sunbeam engine and equipping it with guns. The combination was quite good, and, as far as I can recollect, it had a top speed of about 103 m.p.h., but rather a poor climb. I think the type might have been further developed if it had been pushed. The Services could not be convinced that the machine was adequately strong when fitted with such a large engine and I must confess that we ourselves thought we were very daring."

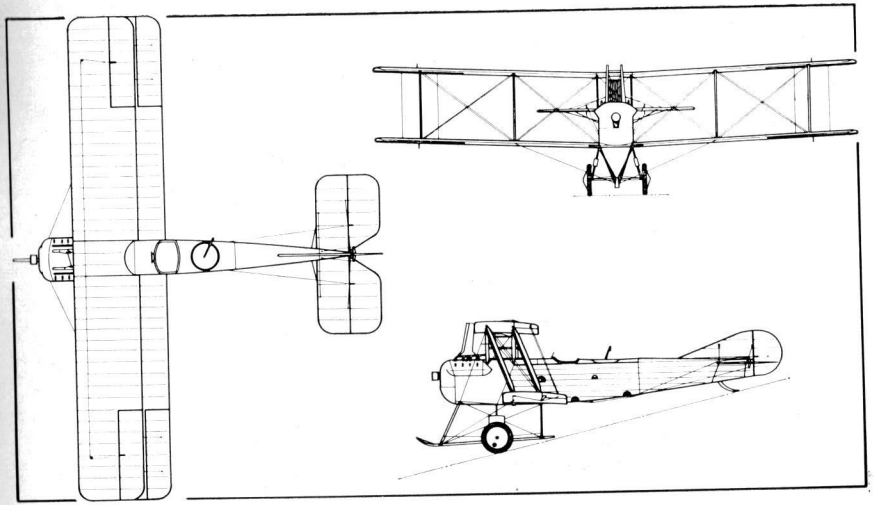
The aircraft in question was the Avro 527, a two-seater powered by a 150 h.p. Sunbeam Nubian engine that was designed in December 1915. Its Avro-504 ancestry was proclaimed by the mainplanes, undercarriage and tail unit; this last incorporated the fin and plain rudder of the Avro 504B. The lower wings were cut away at the roots to improve the pilot's downward vision.

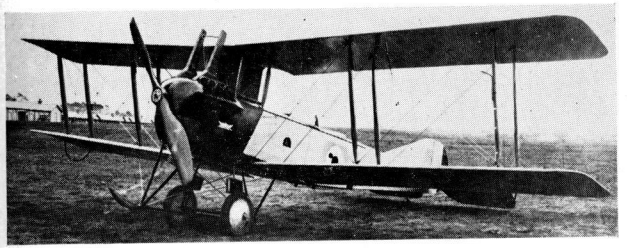
In the design of its fuselage the Avro 527 differed markedly from its predecessors. The pilot sat well aft, in line with the trailing edge of the lower wings; the observer's cockpit, a short distance farther aft, had a form of pillar mounting for a single Lewis gun.

Despite its naval-type fin and rudder the Avro 527 was built for the R.F.C. It was reported to be at Farnborough on 13th February



The Avro 527 at Farnborough, 30th March 1916.





Avro 527.

1916 and was still there at the end of the following month. It seems to have been abandoned soon after that date, no doubt because the Sopwith 1½-Strutter was in prospect. A development, the Avro 527A with wings of 42-ft. span, was not built.

Type: *Two-seat Fighter.* **Power:** *One* 150 *h.p. Sunbeam Nubian eight-cylinder water-cooled engine.* **Armament:** *One* 0.303 *Lewis machine gun on mounting on rear cockpit.* **Performance:** *Maximum speed* 103 *m.p.h. at ground level.* **Weights:** *No details available.* **Dimensions:** *Span,* 36 *ft. No further details available.*

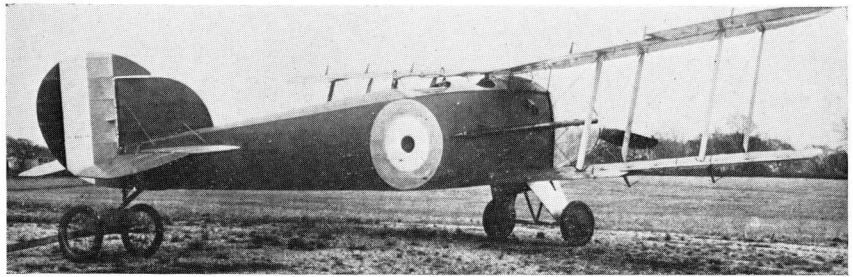
AVRO 530

The Avro 530 represented a breakaway from the basic Avro 504 design. It was a two-seat fighter designed in 1916, and had several advanced features.

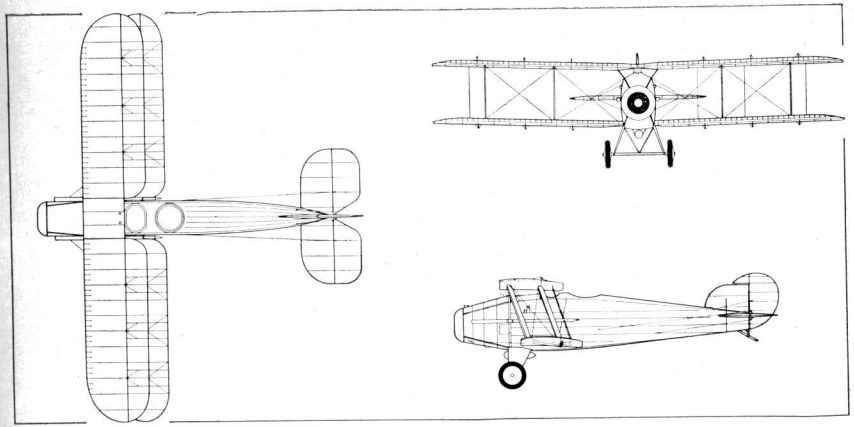
Cleanness of design and the crew's field of view had been carefully considered. There was a large spinner on the airscrew, with a central aperture to admit air to the radiator; the undercarriage V-struts were faired over. The main attachment point of the upper centre section was a central pylon which housed within its fairing the pilot's fixed Vickers gun; there were four small stays connecting the centre section to the upper longerons. The fuselage was deep, and the pilot sat with his eyes level with the upper wing; the observer's cockpit was a short distance aft.

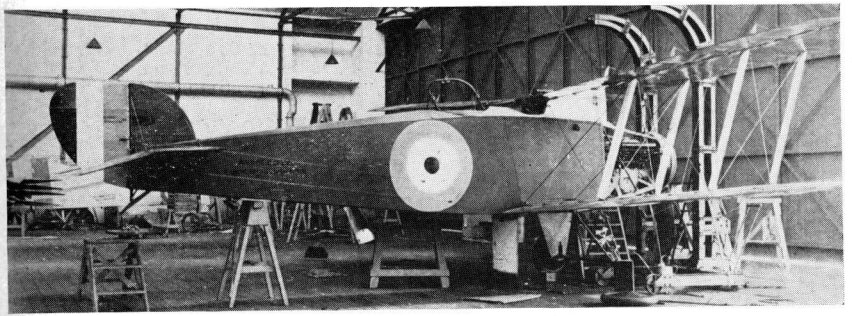
The staggered wings had rounded tips and were of R.A.F. 14 section. The entire trailing portion of each wing inboard of the aileron was movable, and acted as a variable-camber device; it was actuated by a wheel in the cockpit. An alternative set of wings, of R.A.F. 15 section and having no variable-camber flaps, were made for comparative trials. The girder-work in the ribs was made of aluminium in place of the more conventional plywood.

The design of the fin and rudder underwent modification. Originally a small fin and plain rudder were fitted; a later design had a horn-balanced rudder that blended with the outline of the fin. All surviving photographs depict the form illustrated, with the rudder balance above the fin.



The Avro 530 with enlarged fin and balanced rudder.





The Avro 530 with its original fin and rudder.

The Avro 530 with enlarged fin and balanced rudder, at Hamble.

Construction of the Avro 530 was undertaken at the Manchester works of A. V. Roe & Co. Ltd. The components were sent to Hamble on 3rd May 1917 for assembly, but it appears that the aircraft was not completed until July 1917.

Performance proved to be good, but the Avro 530 was unable to improve significantly on the speed and climb of the contemporary Bristol F.2A which was already in production and under further development, and was a better all-round aircraft. The Avro 530 suffered from the further disadvantage of having the engine that was the standard power unit of the S.E.5a and, in 1917, was wanted almost exclusively for that aircraft.

The Avro 530 was not completely abandoned however. In 1918 it was fitted with a 200 h.p. Sunbeam Arab engine, possibly to act as a flying test bed. In this form the Avro 530 had a modified undercarriage. Wider V-struts, without fairings, were fitted; their forward legs met the fuselage nearer the nose. No further development of the aircraft was then possible, for the Arab was beset by many difficulties.

Type: *Two-seat Fighter.* **Power:** *One* 200 *h.p. Hispano-Suiza* 8*Bd or* 200 *h.p. Sunbeam Arab eight-cylinder water-cooled engine.* **Armament:** *One fixed, synchronized* 0.303-*in. Vickers machine-gun; one* 0.303-*in. Lewis machine gun on Scarff ring on rear cockpit.* **Performance:** *Maximum speed* 114 *m.p.h. at ground level,* 102 *m.p.h. at* 10,000 *ft.; climb to* 10,000 *ft.,* 15 *min.; ceiling,* 18,000 *ft.; endurance,* 4 *hours.* **Weights:** *Empty,* 1,695 *lb.; loaded,* 2,680 *lb.* **Dimensions:** *Span,* 36 *ft.; length,* 28 *ft.* 6 *in.; height,* 9 *ft.* 7 *in.; wing area,* 325.5 *sq. ft.*

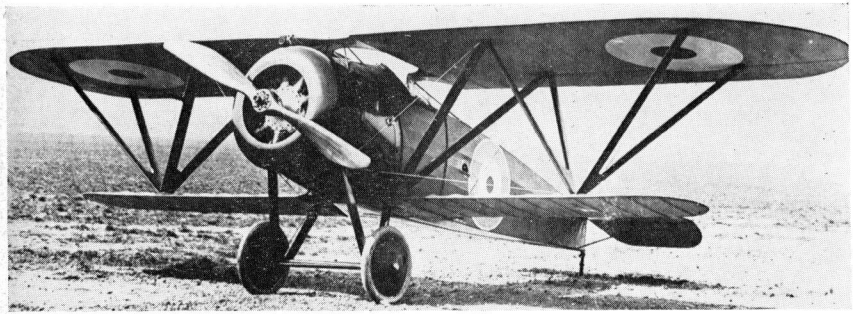
AVRO 531 SPIDER

The Avro 531 was a single-seat fighter that was designed by Roy Chadwick to test his theory relating to manoeuvrability: he believed it should be possible to design an aircraft that was fairly stable, had a rigid structure and powerful, well harmonized controls, and was yet manoeuvrable.

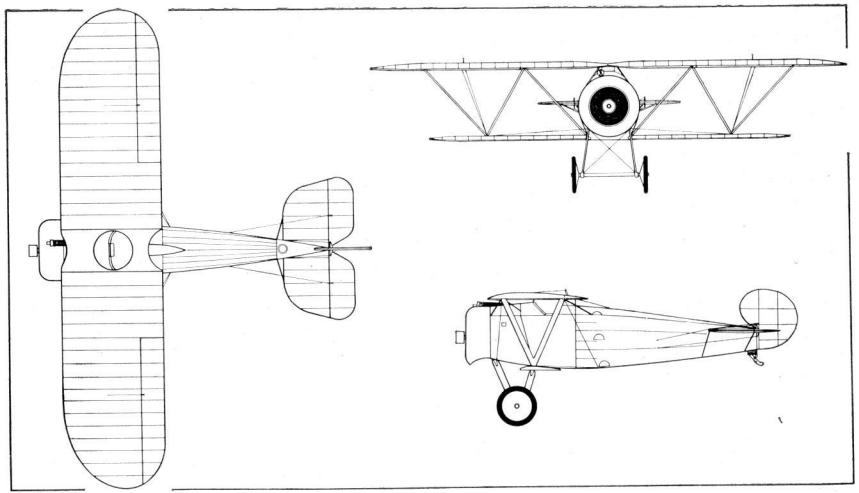
To this end he designed a small sesquiplane; the chord of the upper wing was 6 ft., of the lower, 2 ft. 6 in.; the wing structure was braced by a Warren-girder system of V-struts. Each V-strut consisted of two faired steel tubes, and there were neither landing nor flying wires. Wing spars and fuselage members were of spruce, and the airframe was fabric covered. To speed the completion of the prototype and to facilitate production several Avro 504K components were embodied in the Avro 531 and the entire forward fuselage was identical with that of the 504K.

The upper wing was mounted close to the fuselage and directly above the cockpit. The pilot sat in a central aperture in the wing, which was level with his eyes. His field of vision was therefore excellent. Ailerons were fitted to the upper wing only; the rudder was a scaled-down replica of that of the 504.

Nicknamed "Spider", the Avro 531 was built as a private venture; it appeared in April 1918. In its original form it had a 110 h.p. Le Rhône engine that had been "borrowed" for the purpose, presumably from 504K production. Its manoeuvrability amply vindicated its designer's beliefs: in mock combat it outmanoeuvred standard contemporary scouts. Performance was good, but not significantly better than that of the Camel, which was then in quantity production.



The Spider with 110-h.p. Le Rhône engine.

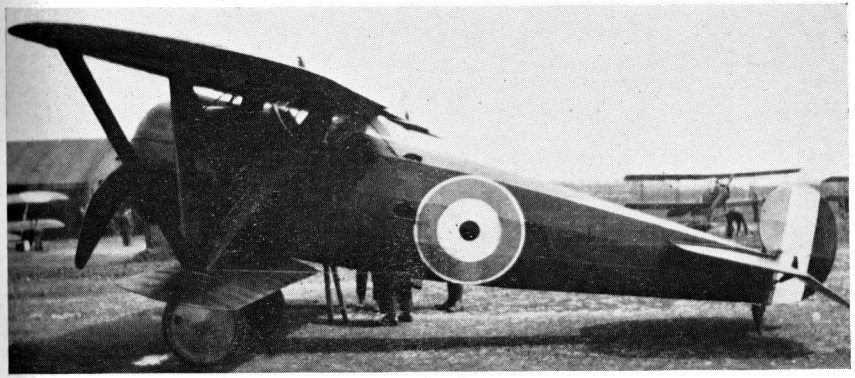


On several counts the Spider earned the commendation of all who flew it: it was viceless and light on the controls; its cockpit was roomy and comfortable; the disposition of the Vickers gun and ammunition box was good.

But the Spider was not ordered officially. By the time it appeared, other, more advanced designs were in production. It was flown with a 130 h.p. Clerget engine, and the installation of a 150 h.p. Bentley rotary was projected. At one stage a modified engine cowling with external stiffening ribs was fitted.

An alternative version with two-bay wings of equal chord (4 ft. 4 in.), having conventional wire bracing and ailerons on upper and lower wings, was designed, originally with the type number 531A. In this variant the cockpit was immediately behind the rear spar of the centre section, which was designed as a completely open structure.

This design was built in 1919 as the Avro 538, powered by a 150 h.p. Bentley B.R.1. With the civil identity of K-132, later G-EACR, it was used as a personal transport by J. C. C. Taylor on his duties in connexion with the Avro Transport Co.'s fleet of joy-riding Avro 504Ks. It survived only until September 1920.



Avro Spider with modified cowling and changed airscrew.

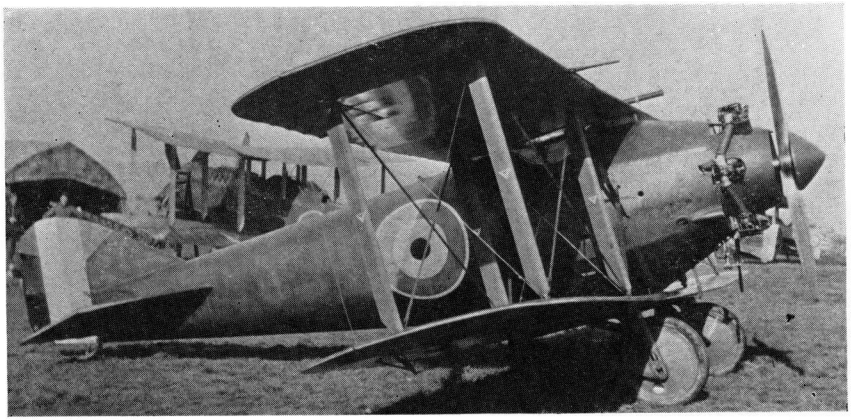
Type: *Single-seat Fighter.* **Power:** *One* 110 *h.p. Le Rhône* 9*J* or 130 *h.p. Clerget* 9*B nine-cylinder rotary engine.* **Armament:** *One fixed, synchronized* 0.303-*in. Vickers machine gun.* **Performance:** *Maximum speed* 120 *m.p.h. at ground level,* 110 *m.p.h. at* 10,000 *ft.; climb to* 10,000 *ft.,* 9 *min.* 30 *sec.; ceiling,* 19,000 *ft.* **Weights:** *Empty,* 963 *lb.; loaded,* 1,517 *lb.* **Dimensions:** *Span, upper* 28 *ft.* 6 *in., lower* 21 *ft.* 6 *in.; length,* 20 *ft.* 6 *in.; height,* 7 *ft.* 10 *in.; wing area,* 189 *sq. ft.*

B.A.T. F.K.22 & F.K.23 BANTAM

In 1917 Frederick Koolhoven left the Armstrong-Whitworth company to become chief designer of the newly formed British Aerial Transport Co. His earliest known design for the B.A.T. concern was the F.K.22, a small single-seat fighter that had some unusual features.

The F.K.22 was a two-bay biplane; the wings had wide-span centre sections, both of which were attached directly to the fuselage. Most of the under-surface of the lower centre section was covered with plywood. The pilot sat with his head and shoulders in a circular opening between the spars; the fuselage filled the interplane gap completely.

Remembering his pre-war experience with Deperdussins, Koolhoven designed a wooden monocoque fuselage for the F.K.22. It had



The original B.A.T. F.K.22 with A.B.C. Mosquito engine.

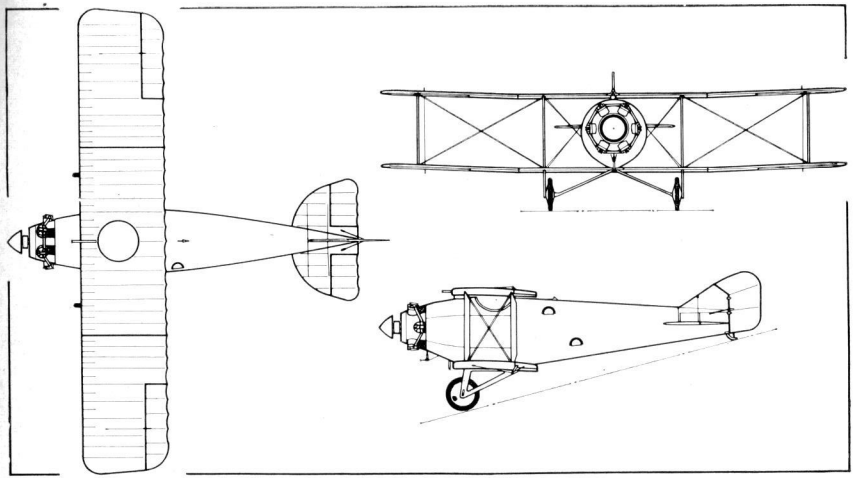
ash formers and was covered with birch three-ply; in cross section it was a near-ellipse. The fin was built as an integral part of the fuselage and was covered with birch three-ply, as also was the forward portion of the tailplane. The wide-track undercarriage had independent suspension for each wheel, using vertical coil springs moving inside the front leg of each V-strut.

Power was provided by the new and experimental 120 h.p. A.B.C. Mosquito engine, a six-cylinder radial mounted on a 10 S.W.G. duralumin plate. It had a small conical spinner on the airscrew, but was also flown without this refinement, the engine then having a hemispherical cowling through which the cylinder heads protruded.

Apparently the B.A.T. F.K.22 was designed as a private venture: its construction was authorized by official Licence No. 11; no contract was given at this time, and the first aircraft appeared without an official serial number. It was known as the B.A.T. Bat, a name that was not official. It seems that the F.K.22 first flew late in September or early in October 1917.

On test the F.K.22 did not prove to be satisfactory. Some, but not all, of its troubles were attributable to the Mosquito engine, which had apparently been installed in the airframe before it had been adequately tested.

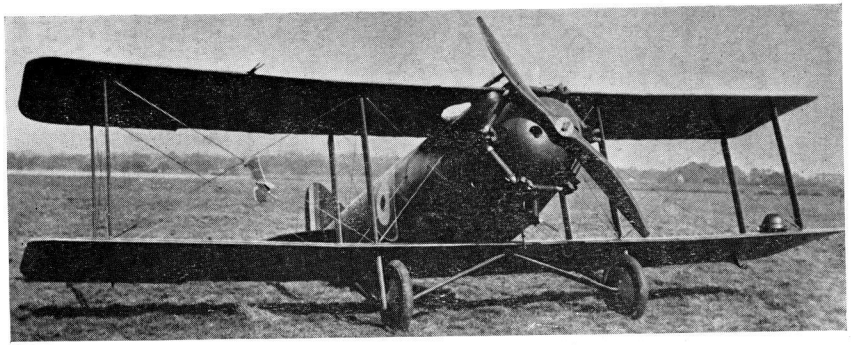
The design must have been considered worth developing, because Contract No. A.S. 25314, for the construction of prototypes, was given to the B.A.T. company. The contract was for six aircraft to be numbered B9944–



B.A.T. F.K.22.

B9949. Their development history was complex, and surviving documentation is scanty and not wholly consistent.

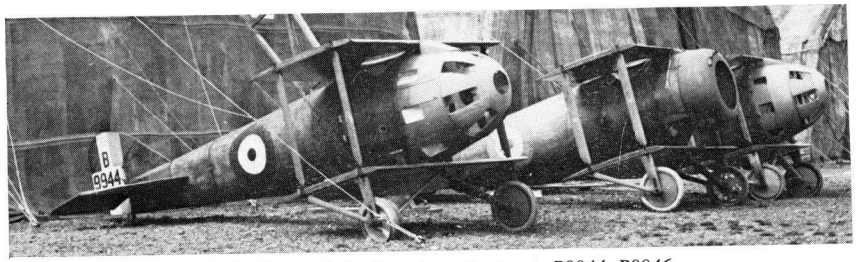
It seems that the first three prototypes, B9944-B9946, all had much the same basic fuselage but represented at least two variations of the F.K.22 design. The first and third aircraft were intended to have the 170 h.p. A.B.C. Wasp seven-cylinder radial engine, B9945 the 100-h.p. Gnôme Monosoupape rotary; some records indicate that the Wasp-powered aircraft had the designation F.K.22/1 and that the rotary-powered version was the F.K.22/2. The wing structure of these aircraft differed slightly from that of the original F.K.22; and on B9945 the interplane struts were of broader chord than those of the other two prototypes. Apparently all three aircraft had been completed by December 1917, during which month the original F.K.22 was dismantled for spares. One report suggests that no Wasp engines were available when the first F.K.22/1 was completed, and that it made its first flight late in 1917 with a 120-h.p. A.B.C. Mosquito. This may, however, be a confusion with the original F.K.22. Reports state that a Wasp engine was being fitted to the F.K.22/1 in the second week of January 1918, and that a "larger machine" designed for the Wasp would be ready as soon as a further engine was available. The identity



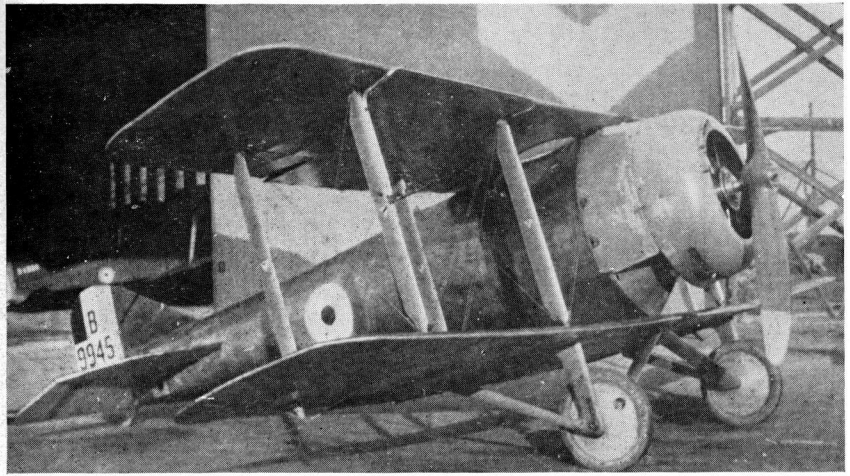
The F.K.22 with modified Mosquito installation

of this larger machine is unknown. It may have been B9946; alternatively, it may have been one of the F.K.23 prototypes that, as described below, were awaiting engines in March 1918.

The performance of the F.K.22/1 with the Mosquito engine was so poor that the Royal Aircraft Factory made an investigation of the engine and its airscrew. When the A.B.C. Wasp was installed the aircraft had a satisfactory performance, but the engine gave a foretaste of the waywardness that was to become



The fuselages of the first three Bantams, B9944–B9946.

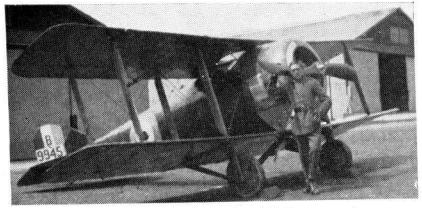


F.K.22/2 with 100-h.p. Gnôme Monosoupape, at Martlesham Heath.

its most exasperating characteristic and was replaced by another Wasp in February.

Makers' trials of B9945 indicated the need for an increase in the size of the tail surfaces; after modification the aircraft went to Martlesham on 19th January 1918 and underwent official tests there in the following month. Apparently it was considered likely to be useful as an advanced training aircraft for fighter pilots. At a later stage its Monosoupape engine was replaced by a 110 h.p. Le Rhône. When, under the first official scheme of aircraft nomenclature, the Wasp-powered F.K.23 was designated Bantam I, the F.K.22/2 was given the name Bantam II.

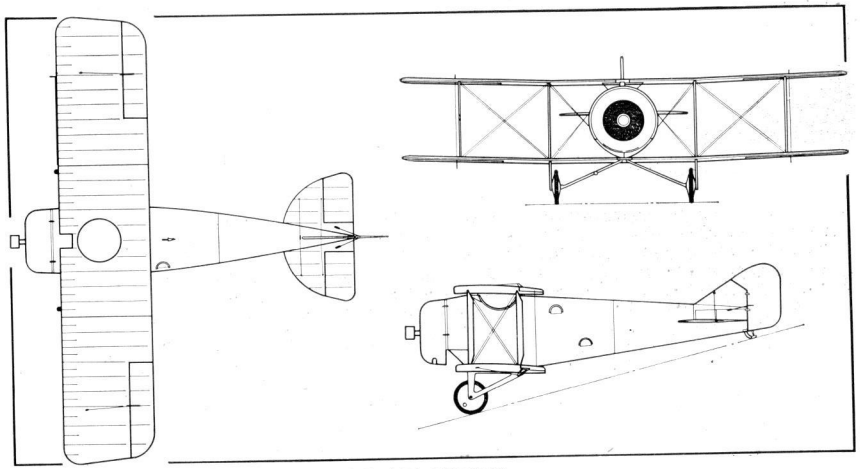
Records of the later prototypes are confused and inconclusive. Four were reported to be waiting for their engines in March 1918; this number probably included B9946. One, described as "Baby", had small wings; it was fitted with a larger tailplane and strengthened engine bearers while awaiting its Wasp engine, which arrived late in April. Another so-called Baby was reported to have large wings; it underwent makers' trials on 18th March 1918, but its engine was faulty and had to be returned to the makers. The other two experimental aircraft were said to have large fuselages, one having small wings, the other large wings.



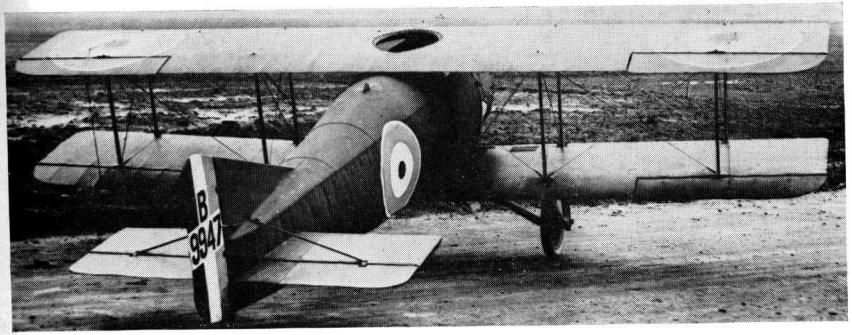
B9945 with 110-h.p. Le Rhône engine.

As complete photographic and documentary evidence of the existence and nature of these four B.A.T. types has still to be found, it is difficult to be certain about their identities, but it seems a safe assumption to regard B9947 as the "Baby" with small wings. It was completely different from, and appreciably smaller than, the F.K.22; but in its basic features it resembled its predecessors. It had a monocoque fuselage that filled the interplane gap, and the pilot sat with his head in the central cut-out of the upper wing. The wings again had wooden interplane struts and two-bay bracing; and the wide-track, divided-axle undercarriage was fitted.

On B9947, however, the fuselage was made on different lines: the plywood covering was applied in three pieces round the fuselage between each former, the plywood being



B.A.T. F.K.22|2.



The first form of the F.K.23 design, B9947, at Hendon awaiting its Wasp engine.

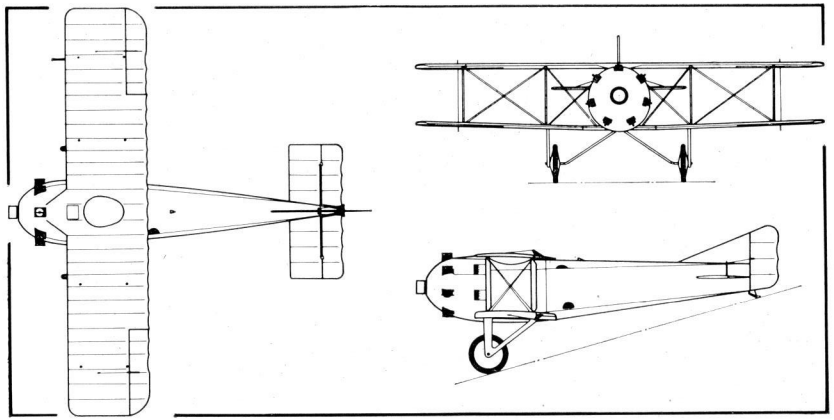
secured by rebated ash beadings running round each former. In cross section the fuselage had a distinct angle at each of the four longitudinals. Two Vickers guns were mounted inside the cockpit at floor level. They fired forward between the lowest pair of engine cylinders on each side.

The upper wing was made in one piece and had no dihedral, but the lower wing had 2°. Span was reduced to a mere 20 ft., the gap to 3 ft.; the wing area totalled 160 sq. ft. The tail unit was completely redesigned. There was a triangular fin, built integral with the fuselage; the plain rudder had a straight, vertical trailing edge, and into its base was built the tail-skid. The tailplane was a simple rectangular surface, strut-braced to the upper longerons.

One official document unequivocally calls the B9947 design B.A.T. F.K.23 Bantam, and there is little doubt that this designation was appropriate to more than one type of B.A.T. aircraft.

It is known that B9947 was flown at the Royal Aircraft Establishment, Farnborough, between 15th September and 26th October 1918. These dates almost certainly do not mark the limits of the aircraft's stay at the R.A.E., but it is of interest that the earliest recorded reference to B9947's presence at Farnborough comes almost two months later than the arrival there of F1653, the first of the Bantams built to the final F.K.23 design. While still flying from Farnborough on 23rd September 1918, B9947 survived undamaged a forced landing at Winchester, doubtless caused by engine failure. Its ultimate fate is unknown.

One source suggests that the other "Baby", which had larger wings, went to Martlesham Heath, but what it did there is not known. Detailed references to the two prototypes with the larger fuselage have yet to be found, but it seems possible that the second of them may have been the aircraft that was the true prototype of the final F.K.23 Bantam.



B.A.T. F.K.23, first form.

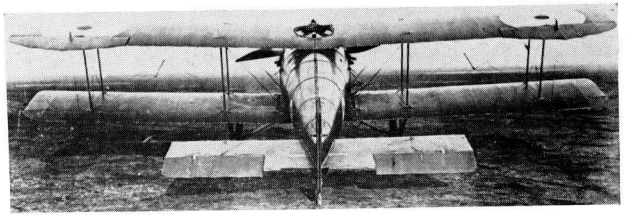
It is known that this prototype emerged in the spring of 1918, and that it was designated F.K.23. Like its predecessors it was a two-bay biplane with the upper wing attached directly to the fuselage; again the pilot sat with his head in a central cut-out in the upper wing. The wide-track undercarriage with vertical coil springs in the forward legs of the V-struts was again employed, and the A.B.C. Wasp was retained as the power unit.

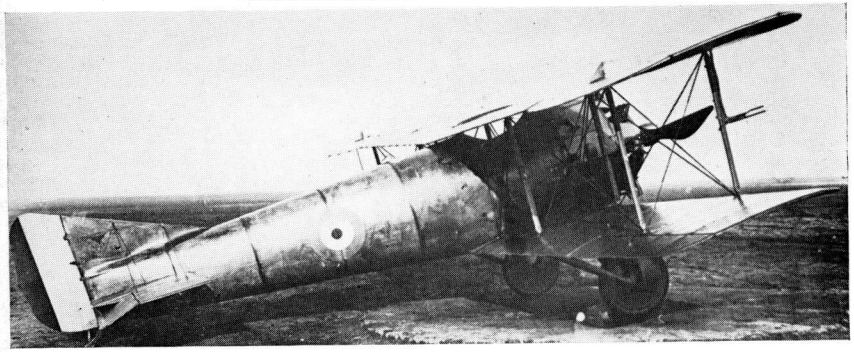
Overall dimensions were increased, and the new F.K.23 was of better proportions than B9947. The monocoque fuselage embodied four ash longerons supporting a series of frames; there were spine and keel members abaft the cockpit, and the whole was covered with plywood. There were no "angles" at the longerons as on the B9947-type fuselage, and the cross section was a smooth ellipse. The triangular fin was made as an integral part of the fuselage. Interplane struts of steel tubing replaced the wooden struts of the earlier types.

The first aircraft built to the revised F.K.23 design bore no serial number, for a time at least, consequently its precise identity is uncertain. It was not fitted with armament. It had a narrow-chord rudder and short-span ailerons; the elevators were unusually disposed, each occupying the outer two-thirds of the tailplane on each side. The span of the tailplane was 9 ft. 2 in., a considerable increase over the 6 ft. 7 in. span of the horizontal surface on B9947.

Aileron control proved to be inadequate. A somewhat makeshift remedy was tried by enlarging the upper ailerons: the chord of each

Revised F.K.23 Bantam at Martlesham Heath with upper ailerons enlarged at mid-span.

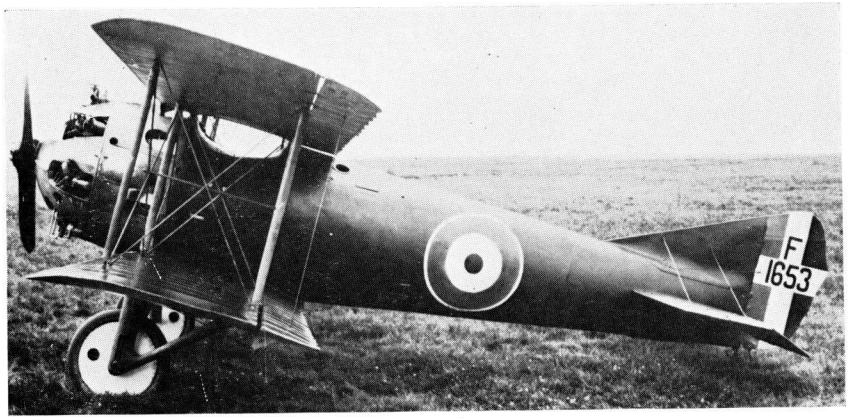




was increased at the middle, thus giving a curving outline to the trailing edge. In this form the Bantam was tested at Martlesham.

A development batch of Bantams to the final design were ordered; at least nine, numbered F1653–F1661, were built. These aircraft had constant-chord ailerons of increased span on all four wings. An enlarged rudder of characteristic profile was introduced at this stage and remained standard for the type. The horizontal tail surfaces also underwent minor modifications: the span of the elevators was slightly increased, but they were still widely separated. Two Vickers guns were installed, as on B9947, low down within the fuselage.

It was in this form that Bantam F1653 arrived at the Royal Aircraft Establishment, Farnborough, on 26th July 1918; it had been flown from Hendon by Peter Legh, the B.A.T. test pilot. This was precisely one month after a Technical Department fortnightly progress report had recorded that trials of the three Wasp-powered fighters (the Bantam, Snail and



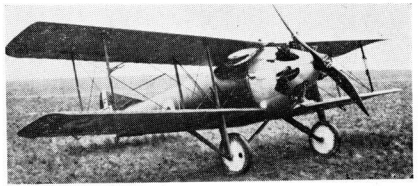
Final form of F.K.23 Bantam.

Wagtail) had been suspended "until engine troubles had been overcome". These troubles were never overcome.

It is known that F1654 was at Farnborough on 10th and 13th August 1918, and that it was also flown at Martlesham and Orfordness. On this and subsequent Bantams there was a small notch in the upper mainplane abaft the rear spar on the centre line; and on F1655–F1661 rubber-cord shock absorbers replaced the coil springs used on the earlier aircraft.

A Bantam of the final batch went to France in the late summer of 1918: with it went Peter Legh. It was flown at Villacoublay, presumably for evaluation purposes. One of the French pilots who flew this Bantam was the celebrated Roland Garros.

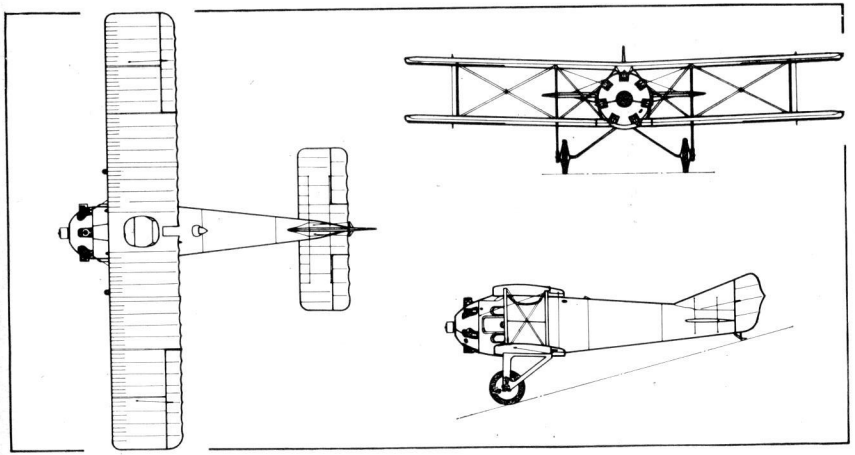
The revised Bantam was fast and manoeuvrable but had alarming spinning characteristics, the speed and range of its auto-rotation being abnormally great. Recovery from a left-hand spin could be sudden and violent, but to the right the aircraft spun fast and would recover only slowly with a considerable loss of height. At the R.A.E. a Bantam was fitted with enlarged tail controls, first with a rudder of 50% greater area, then with elevators with 50% more area, and finally with both enlarged surfaces fitted. It was found that the behaviour and controllability of the Bantam were greatly improved, the greatest improvement being afforded by the combination of the standard rudder and the enlarged elevators. The official report concluded that "the only modifications required to render the control of the Bantam aeroplane satisfactory is to increase the chord of the elevators by six inches". A later (1925) investigation concluded that the combination of narrow gap and zero stagger present in the Bantam was likely to make recovery from a spin difficult unless the centre of gravity was well forward.



Bantam F.1653 with modified engine cowling.

The first report mentioned above was written in September 1920, by which time the Bantam was no longer needed, its Wasp engine was known to be a failure, and the B.A.T. company had been disbanded.

At least one aircraft was fitted with a 200 h.p. A.B.C. Wasp II engine, but this engine was no more reliable than the Wasp I and development was not pursued. Serial numbers (J6579–J6580) were allotted for two more Bantams that were intended to have the Wasp II, but they seem neither to have been delivered nor converted from aircraft of the F1653 batch. By January 1919 the Bantam was officially regarded as abandoned. Farnborough continued to use F1653 for some years, however. In November 1918 it was given



B.A.T. F.K.23, final form.

The F.K.23 Bantam that went to the U.S.A. and was flown at Wright Field.

a modified cowling to improve cooling, and was still flying in the summer of 1921.

Seven of the Bantams acquired civil identities, F1661 becoming successively G-EAYA and H-NACH. In the latter guise it had a 200-h.p. Armstrong-Siddeley Lynx engine, an enlarged rudder and horn-balanced elevators, and achieved a speed of 246 km./hr. (153 m.p.h.) in 1924. Its cockpit was moved aft, behind the upper mainplane.

One aircraft went to the U.S.A., where it was flown at Wilbur Wright Field with the number A.S.94111 and as project No. P-167. This Bantam was placed in store on 30th September 1922.

The Bantam was an aircraft that, given a reliable engine and appropriately modified and developed, might have made a considerable name for itself.

B.A.T. F.K.22
Type: *Single-seat Fighter.* **Power:** (F.K.22): *One* 120 *h.p. A.B.C. Mosquito six-cylinder air-cooled radial engine*; (*F.K.*22/1): *One* 120 *h.p. A.B.C. Mosquito*, 170 *h.p. A.B.C. Wasp I seven-cylinder air-cooled radial engine*; (*F.K.*22/2): *One* 110 *h.p. Le Rhône* 9*J nine-cylinder rotary engine*, 100 *h.p. Gnôme Monosoupape nine-cylinder rotary engine.* **Armament:** *Two fixed, synchronized* 0.303-*in. Vickers machine-guns.* **Performance** (*Gnôme*): *Maximum speed at* 10,000 *ft.*, 100 *m.p.h.*; *climb to* 10,000 *ft.*, 16 *min.* 50 *sec.*; *to* 15,000 *ft.*, 43 *min. Service ceiling*, 14,500 *ft.* **Weights** (*Gnôme*): *Empty*, 866 *lb.*; *loaded*, 1,260 *lb.* **Dimensions:** *Span*, 24 *ft.* 8 *in.*; *length* (*Gnôme*), 20 *ft.* 8 *in.*; *height*, 7 *ft.* 5 *in.*; *wing area*, 230 *sq. ft.*

B.A.T. F.K.23, first form (B9947)
Type: *Single-seat Fighter.* **Power:** *One* 170 *h.p. A.B.C. Wasp I seven-cylinder air-cooled radial engine.* **Armament:** *Two fixed, synchronized* 0.303-*in. Vickers machine-guns.* **Dimensions:** *Span*, 20 *ft.*; *wing area*, 160 *sq. ft. No further details available.*

B.A.T. F.K.23, second form (as F1653)
Type: *Single-seat Fighter.* **Power:** *One* 170 *h.p. A.B.C. Wasp I*; 200 *h.p. A.B.C. Wasp II seven-cylinder air-cooled radial engine.* **Armament:** *Two fixed, synchronized* 0.303-*in. Vickers machine-guns.* **Performance** (*Wasp I*): *Maximum speed* 128 *m.p.h. at* 6,500 *ft.*, 125.5 *m.p.h. at* 10,000 *ft.*, 118 *m.p.h. at* 15,000 *ft. Climb to* 10,000 *ft.*, 9 *min.*; *to* 15,000 *ft.*, 17 *min.* 5 *sec. Service ceiling*, 20,000 *ft. Endurance*, 2¼ *hours. With Wasp II maximum speed at* 10,000 *ft. was* 146 *m.p.h.*; *climb to* 17,000 *ft.*, *in* 16 *min.* **Weights** (*Wasp I*): *Empty*, 833 *lb.*; *loaded*, 1,321 *lb.* **Dimensions:** *Span*, 25 *ft.*; *length*, 18 *ft.* 5 *in.*; *height*, 6 *ft.* 9 *in.*; *wing area*, 185 *sq. ft.*

B.A.T. F.K.25 BASILISK

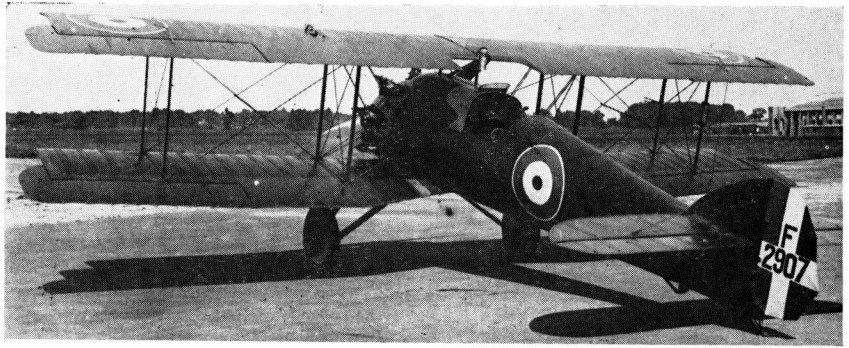
As a successor to the A.B.C. Wasp engine Granville Bradshaw designed the A.B.C. Dragonfly, a nine-cylinder radial that promised a remarkable power-weight ratio. The Air Board ordered over 11,000 Dragonfly engines, and many British aircraft designed in 1918 were intended to have this power unit.

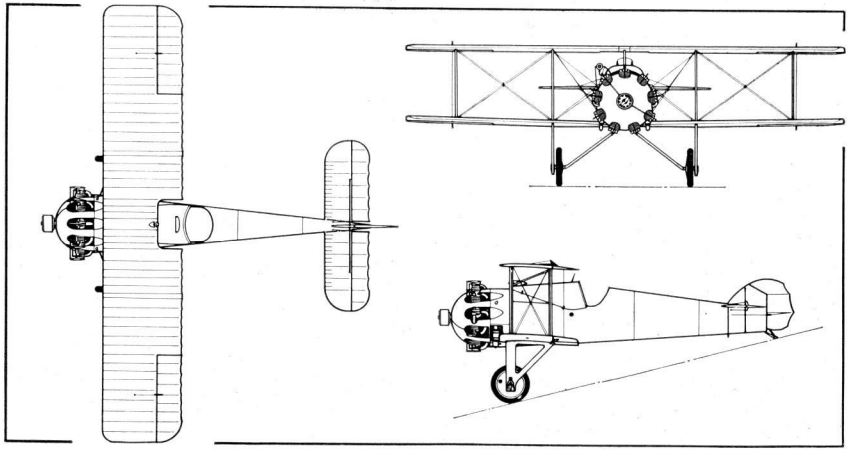
One such was the B.A.T. Basilisk, a stumpy, ugly little biplane that had a monocoque fuselage, two-bay wings, and the sturdy divided undercarriage favoured by Koolhoven. In the possession of these features the Basilisk was on common ground with the Bantam but it had none of the elegance of the earlier type.

In the Basilisk the fuselage was relatively shallow, and a large hood-like decking was fitted in front of the cockpit to enclose the guns and shield the pilot. The gap was increased and the upper wing raised well above the fuselage. There was no centre section: the halves of the upper mainplane met at a central N-strut.

Three prototypes, F2906–F2908, were

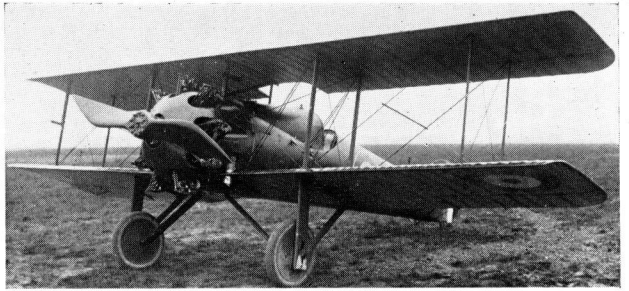
The first Basilisk, F2906.





Right and below, The first Basilisk, F2906.

Left, The second Basilisk, F2907, at Martlesham Heath.



ordered, and work began in the spring of 1918. The fuselage of the first aircraft was almost complete by the end of June 1918, and F2906 appeared later that year. This first Basilisk was destroyed on 3rd May 1919 while on a flight from Hendon. It caught fire in flight and crashed at East Finchley; the B.A.T. test pilot, Peter Legh, lost his life.

The second Basilisk, F2907, was completed in 1919. It differed from the first in having horn-balanced ailerons and a deeper decking in front of the cockpit. This aircraft was tested at Martlesham in October 1919, when the performance figures quoted below were established. These are considerably more realistic than the figures, presumably provided by the manufacturers, that appeared in contemporary publications, crediting the Basilisk with a speed of 162 m.p.h.

Frederick Koolhoven left the B.A.T. company at the end of 1919. Development of B.A.T. types ceased; in particular, the Basilisk was apparently abandoned at about this time. Apart from Koolhoven's departure, however, the aircraft could not have succeeded, at least while powered by the capricious Dragonfly engine.

Type: *Single-seat Fighter.* **Power:** *One* 320 *h.p. A.B.C. Dragonfly I nine-cylinder air-cooled radial engine.* **Armament:** *Two fixed, synchronized* 0.303-*in. Vickers machine-guns.* **Performance** (*second machine*)**:** *Maximum speed* 142.5 *m.p.h. at* 6,500 *ft.*, 141 *m.p.h. at* 10,000 *ft.*, 135 *m.p.h. at* 15,000 *ft. Climb to* 10,000 *ft.*, 8 *min.* 25 *sec.*; *to* 15,000 *ft.*, 15 *min.* 5 *sec. Service ceiling*, 22,500 *ft. Endurance*, 3¼ *hours.* **Weights** (*second machine*)**:** *Empty*, 1,454 *lb.*; *loaded*, 2,182 *lb.* **Dimensions:** *Span* (*first machine*), 25 *ft.* 4 *in.*, (*second machine*) 26 ft. 11 in.; *length*, 20 *ft.* 5 *in.*; *height*, 8 *ft.* 2 *in.*; *wing area* (*first machine*), 212 *sq. ft.*, (*second machine*) 217.3 *sq. ft.*

BEARDMORE W.B.II

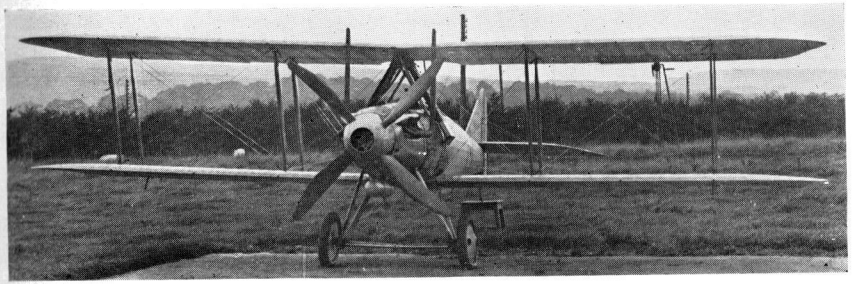
William Beardmore & Co. Ltd. were among the firms that built B.E.2c's for the Admiralty. In 1916 Beardmores set up their own design office, with the late G. Tilghman-Richards as chief designer.

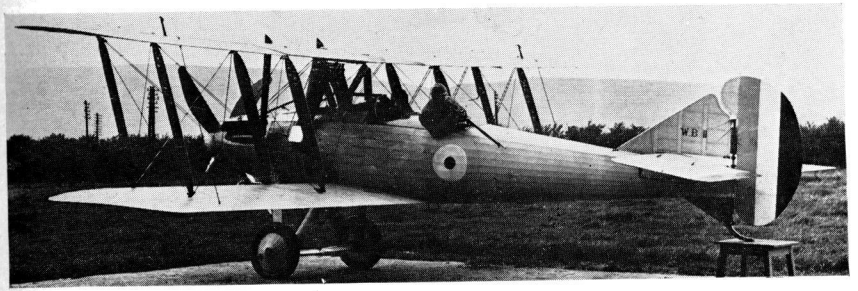
Recognizing the deficiencies of the B.E.2c as a military aircraft, Richards sought permission to build a development with a more powerful engine and cleaned-up fuselage. The resulting design was the Beardmore W.B.II, apparently undertaken as a private venture with the Beardmore works contract No. 1133. Later, the official Contract No. A.S.2864/18 was granted.

As originally conceived, the W.B.II was designed for the 160 h.p. Beardmore six-cylinder in-line engine, and embodied the B.E.2c fin and rudder and most of the basic structure of the B.E. mainplanes. The W.B.II fuselage had good lines and was faired out to a roughly circular cross-section throughout its length. A large upright exhaust pipe led to a silencer mounted centrally above the upper wing. The most important difference between the W.B.II and the B.E.2c lay in the fact that the Beardmore two-seater had its pilot in the front seat, armed with a fixed Vickers gun; the rear cockpit was fitted with a ring mounting for the observer's free Lewis gun.

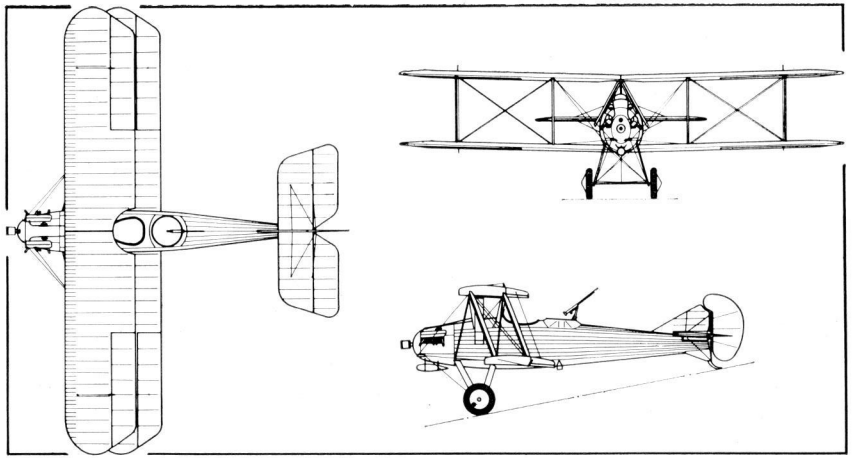
The design was modified, and the W.B.II was built with a 200 h.p. Hispano-Suiza V-eight engine driving a four-blade airscrew that had a large open-fronted spinner; twin upright exhaust stacks were fitted and the two radiator blocks were installed in an inverted V immediately behind the front cabane struts. The areas of the fin and rudder were increased, the latter being horn-balanced. The observer's gun ring was mounted directly on the upper longerons; the gun-mounting, designed by Mr. Tilghman-Richards, was a unique device. The gunner's seat was on a kind of "witch's broom-stick", one end of which pivoted on a ball joint on the cockpit floor, the other travelling round the ring and having an extension to carry the gun and a locking device. Twin Vickers guns were provided for the pilot.

The W.B.II made its first flight on 30th August 1917, piloted by A. Dukinfield Jones. At some time during its early existence the aircraft's four-blade airscrew was replaced by one with two blades. Further modifications followed, probably during the second half of



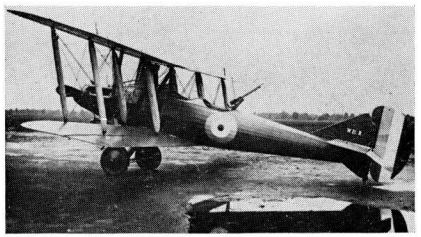


Two views of the Beardmore W.B.II in its original form at Dalmuir.

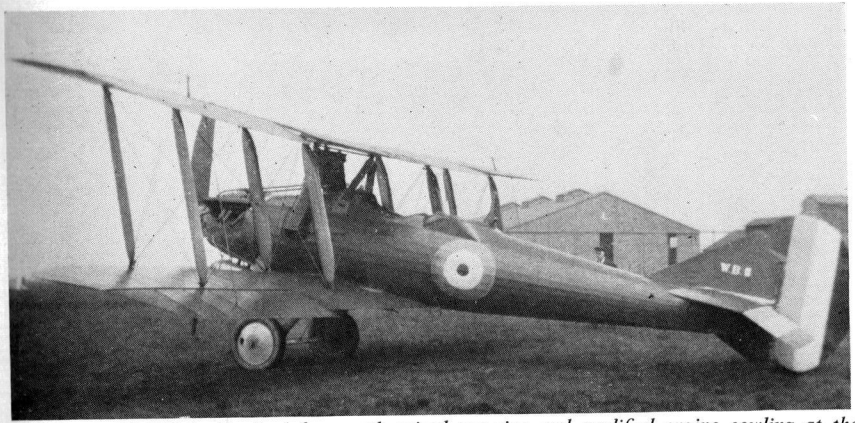


October and November 1917, and by the time the W.B.II went to Martlesham on 6th December 1917 its engine had been moved forward, the spinner removed and the nose contours altered; long exhaust stubs replaced the original stacks, the gun ring on the rear cockpit had been raised 5½ inches, the shape of the underslung oil tank had been improved, and the original steel petrol tanks had been replaced by aluminium ones.

Performance was quite good, and the official test report stated: "Manoeuvrability is very fair and the machine easy to land." The W.B.II was not an improvement on types then in service, however, and it had an engine that was scarce and badly needed for S.E.5a's. The Beardmore two-seater did not go into production, nor was its development, the W.B.IIA with 230 h.p. B.H.P. engine, built. Two examples of a civilian mail-carrying version



Beardmore W.B.II with two-blade airscrew, at Martlesham Heath.



Beardmore W.B.II in its final form with raised gun-ring and modified engine cowling at the Isle of Grain.

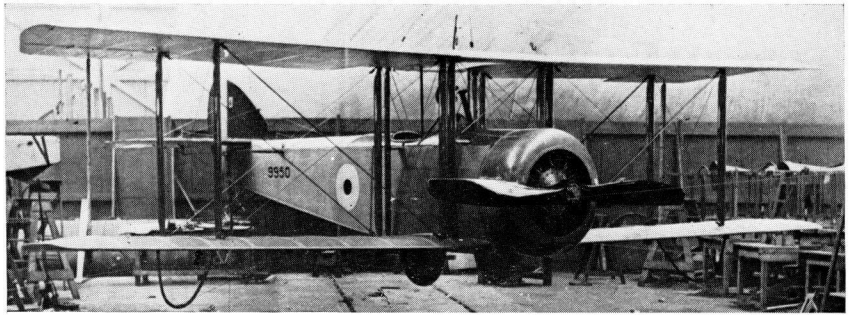
were produced in 1920 with the designation Beardmore W.B.IIB.

Type: *Two-seat Fighter.* **Power:** *One* 200 *h.p. Hispano-Suiza* 8*Bd eight-cylinder water-cooled engine.* **Armament:** *Two fixed, synchronized* 0.303-*in. Vickers machine-guns; one free* 0.303-*in. Lewis machine-gun on Beardmore-Richards mounting.* **Performance:** *Maximum speed* 120 *m.p.h. at ground level,* 111.5 *m.p.h. at* 10,000 *ft. Climb to* 5,000 *ft.,* 10 *min., to* 10,000 *ft.,* 14 *min.* 40 *sec. Service ceiling,* 17,000 *ft. Endurance,* 2.8 *hours.* **Weights:** *Empty,* 1,765 *lb.; loaded,* 2,650 *lb.* **Dimensions:** *Span,* 34 *ft.* 10 *in.; length,* 26 *ft.* 10*in.; height,* 10 *ft.; wing area,* 354 *sq. ft.*

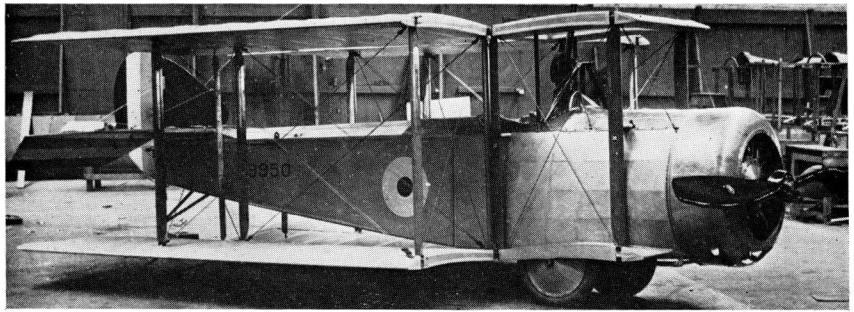
BEARDMORE W.B.III

Wartime deck-flying was pioneered by the Bristol Scout C and furthered by Sopwith 9901 Pups of the R.N.A.S. These aircraft were expected to serve as anti-airship fighters, operating from gun-turret platforms on capital ships and from such carrier vessels as H.M.S. *Manxman, Furious, Argus* and *Campania.*

Hangar space was at a premium on these ships and their contemporaries. The larger ship-borne seaplanes had folding wings, and it was obvious that it would be advantageous for the Pups to have some means of folding also. The Beardmore company, the first contractors to manufacture the Pup under



Prototype Beardmore W.B.III with undercarriage folded and (below) completely folded.



licence, produced the W.B.III, a variant of the Pup that was extensively modified to that end. Mr. G. Tilghman-Richards was responsible for the design work.

To facilitate the folding of the mainplanes the wing cellule was completely redesigned. Stagger was eliminated, and full-gap interplane struts connected the centre section to the lower stub wings; steel tubes running athwartships connected these struts to the upper longerons. On the prototype (which was the Pup No. 9950 modified) and on the first production machines

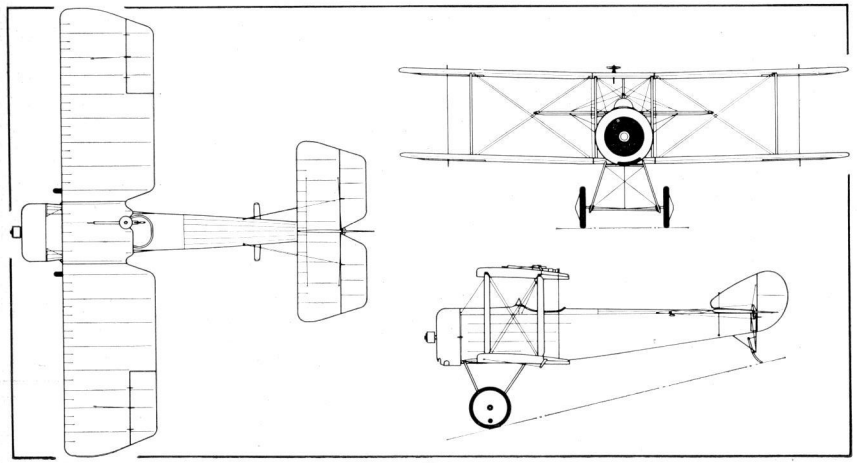
interplane struts were fitted at the inboard ends of the spars of the outer wing panels. The fuselage was similar in construction to that of the Pup but was about a foot longer overall. The standard Pup tail unit was used; the mainplanes were basically Pup components modified at the roots for folding.

On the prototype the undercarriage could be folded into the bottom of the fuselage. This reduced its track drastically, and folding skids were fitted under the lower wing tips.

The prototype, No. 9950, was accepted at Eastchurch on 7th February 1917. One hundred production W.B.IIIs were ordered (N6100–N6129 and N6680–N6749). The first thirteen had the folding undercarriage of the prototype and, like 9950, had struts at the inboard ends of the mainplanes, and the rod-operated, strut-connected ailerons of the prototype. The Lewis gun was mounted on a tripod in front of the cockpit and fired upwards through a cut-out in the centre section.

The first production W.B.III, N6100, flew for the first time on 25th June 1917. When only three more aircraft had been tested production was held up for a month because a consignment of Le Rhône engines had been aboard a ship sunk in the Channel, and N6104 did not fly until 10th August.

The folding undercarriage was not a success, and N6101 was soon tested with a jettisonable undercarriage consisting of two steel-tube V-struts with their upper ends connected by spanwise lengths of steel tubing. If obliged to come down on the sea, the pilot could drop his wheels and minimize the risk of over-



turning on striking the water. Official test reports indicate that the undercarriage weighed 21 lb., and that the W.B.III's performance was not significantly better when flown without it.

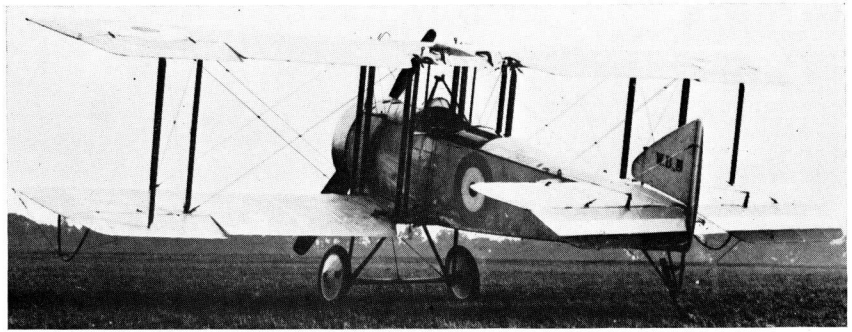
Production W.B.IIIs from N6113 onwards had the jettisonable undercarriage. This form of the design was officially known as the S.B.3D, the suffix D denoting dropping undercarriage; the earlier version was designated S.B.3F, the F signifying folding undercarriage. The aircraft was more commonly known as the Beardmore folding Pup, however. On the S.B.3D the interplane struts at the inboard ends of the spars were discarded, and the aileron control system was modified, cables replacing the rods and inter-aileron struts of the earlier version. The wing-tip skids were removed and the Lewis gun was mounted above the centre section, where it fired forward over the airscrew; there was no cut-out in the centre section.

Flotation gear was fitted to the S.B.3D. An inflatable air bag ran along the underside of the leading edge of each lower mainplane; when deflated it lay almost flush with the wing undersurface. An early test of this equipment was made by Lt. W. G. Moore, D.S.C., from the Isle of Grain: he dropped his undercarriage on the foreshore of Sheerness harbour and then successfully ditched his S.B.3D.

The S.B.3F saw little use. At least six were dismantled for spares at Rosyth in November 1917.

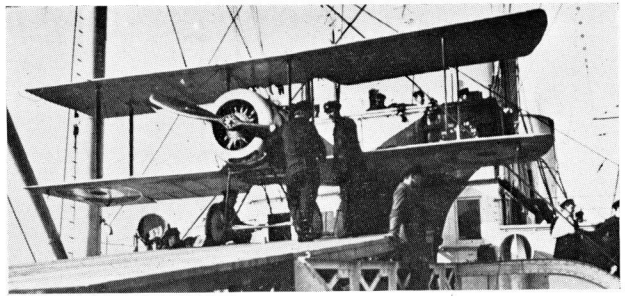
Of the 100 aircraft that were ordered only thirty-six were test-flown at Dalmuir. These were N6100–N6122, N6125–N6127, N6683–N6686, N6689, N6693–N6695, N6698 and N6701; the last of these underwent its acceptance test at Dalmuir on 10th December 1917. The remainder may have gone direct to store.

The Beardmore W.B.III was not particularly popular with pilots. The drastic modifications



Beardmore S.B.3F, N6101, fitted with jettisonable undercarriage. Note the additional interplane struts at inboard ends of folding wings.

of the Pup design impaired its handling qualities; and it inspired little confidence in aerobatics. It did not distinguish itself in any war-like way, although H.M.S. *Furious* had as many as fourteen S.B.3Ds at one time. The carriers *Nairana* and *Pegasus* had S.B.3Ds: those earmarked in August 1917 for the former ship included N6105, N6108 and N6110; while N6104, N6106 and N6107 were delivered during the same month to H.M.S. *Pegasus*. One aircraft, N6115, was used in an unsuccessful attempt to fly from the fo'c'sle of the battle cruiser H.M.S. *Renown*.



Beardmore S.B.3D aboard H.M.S. Nairana.

On 31st October 1918 eighteen S.B.3Ds were with the Grand Fleet and fifty-five were in store. By this time the Sopwith 2F.1 was available in quantities and had a superior performance. Apparently a few S.B.3Ds went to the Japanese navy, but the type disappeared from R.A.F. service shortly after the Armistice.

Type: *Single-seat Shipboard Fighter.* **Power:** *One* 80 *h.p. Le Rhône* 9C *nine-cylinder rotary engine*; 80 *h.p. Clerget seven-cylinder rotary engine.* **Armament:** *One* 0.303-*in. Lewis machine-gun on tripod firing upwards, or on centre section firing forwards.* **Performance:** *Maximum speed*, 103 *m.p.h. at ground level*, 98 *m.p.h. at* 6,500 *ft.*, 91 *m.p.h. at* 10,000 *ft. Climb to* 6,500 *ft.*, 12 *min.* 10 *sec.*; to 10,000 *ft.*, 24 *min.* 20 *sec. Service ceiling*, 12,400 *ft. Endurance*, 2¾ *hours.* **Weights:** *Empty*, 890 *lb., loaded*, 1,289 *lb.* **Dimensions:** *Span*, 25 *ft.*; *length*, 20 *ft.* 2½ *in.*; *height*, 8 *ft.* 1¼ *in.*; *wing area*, 243 *sq. ft.*

BEARDMORE W.B.IV

Whereas the Beardmore W.B.III was a modification of an existing aircraft, the W.B.IV was an entirely original design. Like its predecessor it was intended for use from ships, but it was a very different aeroplane.

The W.B.IV was (for a single-seater) a large aircraft, having two-bay wings of unequal chord; the mainplanes could be folded. The most striking features of the aircraft lay in the fuselage. Few tractor fighters of

the war period can have given their pilots a better forward view than did the W.B.IV. Seated high up in front of the wings, its pilot had an excellent view over the short, steeply sloping nose for fighting or landing-on.

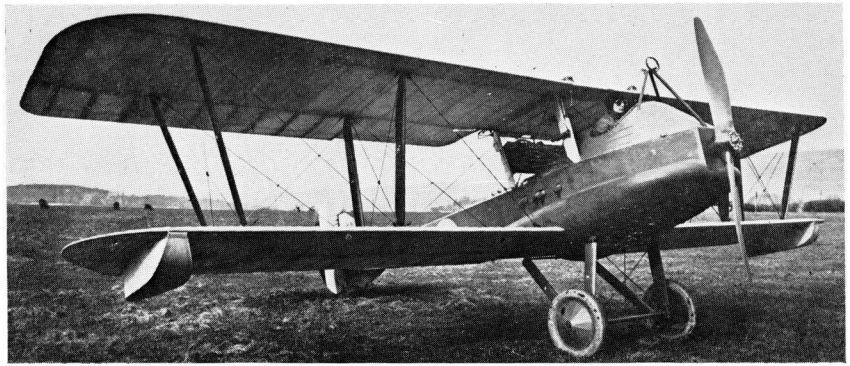
This was achieved by the remarkable expedient of installing the engine, a 200 h.p. Hispano-Suiza, behind the pilot. It was directly under the centre section and drove the airscrew by a long extension shaft that passed between the pilot's legs. The radiator was carried on the rear centre-section struts, and the gravity fuel tank was in the leading-edge portion of the centre section.

Both the W.B.IV and W.B.V were designed to Air Board specification N.1a, which stipulated the provision of a flotation gear that would, in an emergency, keep the aircraft afloat for at least six hours. To meet this requirement the W.B.IV had a large buoyancy chamber in the forward portion of the fuselage. The cockpit was watertight, the undercarriage was jettisonable, and wing-tip floats were provided in order to stabilize the aircraft on the water in the event of an emergency landing. The whole fuselage was covered with plywood.

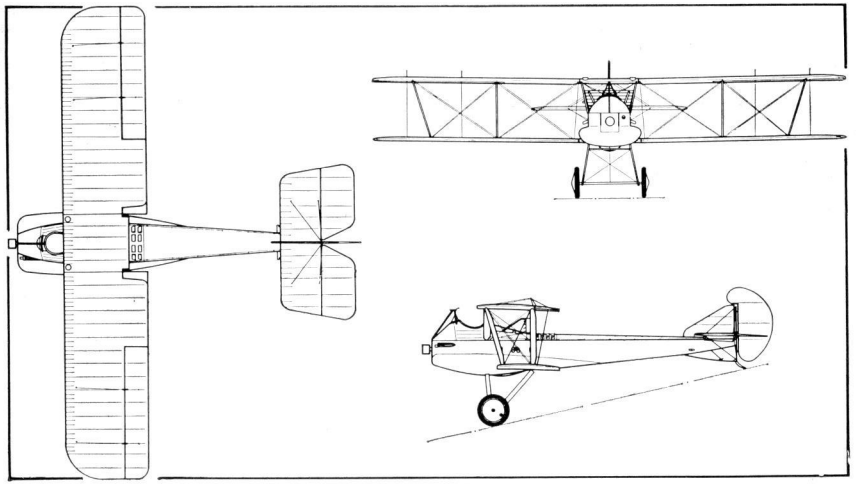
The tail unit was of characteristic design, embodying a rudder that was very similar to that of the W.B.II. For all its ingenious features the W.B.IV yet contrived to be a handsome aeroplane.

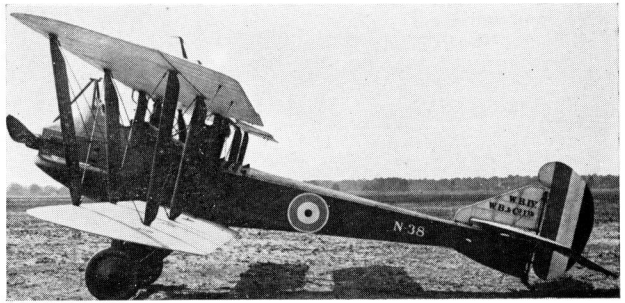
Three prototypes, N38–N40, were ordered. Only one example was built, however: N38 emerged from the Dalmuir works late in 1917. It flew for the first time on 12th December but apparently did little flying there. By the time it reached Martlesham for its official performance trials in July 1918 its wing-tip floats had been removed.

The performance of the W.B.IV was quite



Beardmore W.B.IV in its original form at Dalmuir.





W.B. IV with wing-tip floats removed, at Martlesham Heath.

creditable, considered on its own merits, but it was inferior to that of the simpler and more conventional Sopwith 2F.1, especially in climbing performance. Servicing and replacing the Hispano-Suiza engine would have been unusually difficult, if not impossible, under operational conditions.

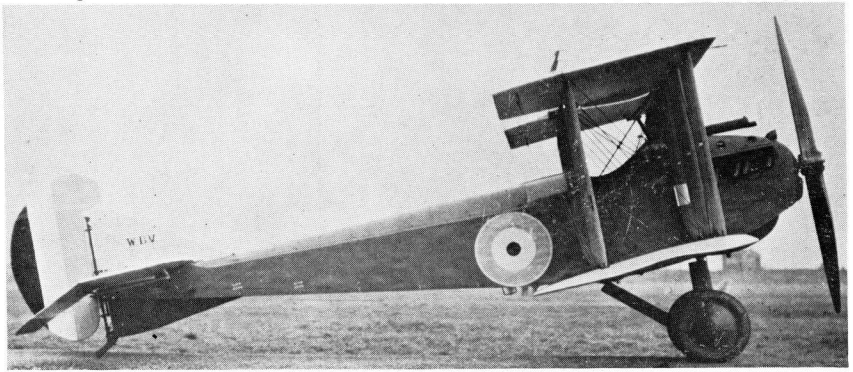
No production of the W.B.IV was undertaken. Apparently the aircraft was returned to the Isle of Grain and was experimentally flown there until, when alighting on the water, its buoyancy chamber was stove-in and the aircraft sank.

Type: *Single-seat Shipboard Fighter.* **Power:** *One* 200 *h.p. Hispano-Suiza eight-cylinder water-cooled engine.* **Armament:** *One fixed, synchronized* 0.303-*in. Vickers machine-gun on port side of fuselage*; *one* 0.303-*in. Lewis machine-gun on tripod mounting in front of cockpit.* **Performance:** *Maximum speed,* 110 *m.p.h. at ground level,* 102 *m.p.h. at* 10,000 *ft. Climb to* 5,000 *ft.,* 7 *min.*; *to* 10,000 *ft.,* 18 *min.* 20 *sec. Service ceiling,* 14,000 *ft. Endurance,* 2½ *hours.* **Weights:** *Empty,* 2,055 *lb.*; *loaded,* 2,595 *lb.* **Dimensions:** *Span,* 35 *ft.* 10 *in.*; *length,* 26 *ft.* 6 *in.*; *height,* 9 *ft.* 10½ *in.*; *wing area,* 350 *sq. ft.*

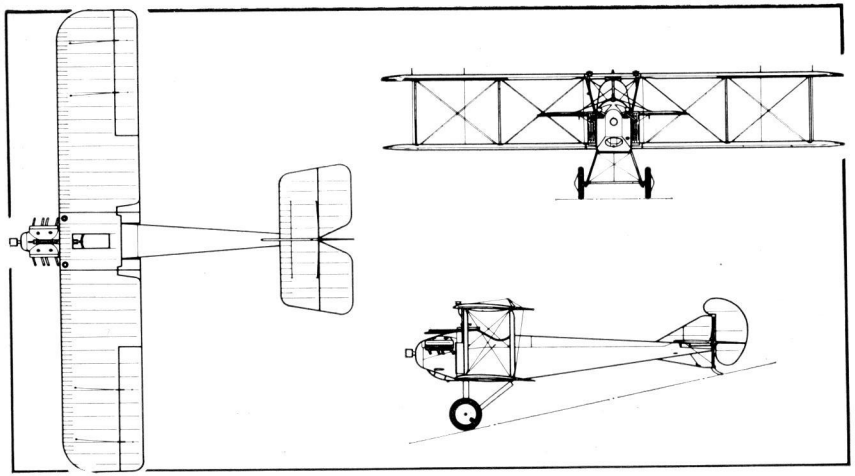
BEARDMORE W.B.V

Contemporary with the W.B.IV and powered by the same basic type of engine, the Beardmore W.B.V was a more conventional design for a ship-board fighter. It was designed to meet an Admiralty specification for a ship-board aircraft armed with a 37-mm. Canon Puteaux quick-firing gun and intended to be an airship destroyer. Again three prototypes, N41–N43, were ordered; the first recorded flight of N41 was made at the Isle of Grain on 3rd December 1917.

The W.B.V fuselage was structurally similar



The first W.B.V, N41, at the Isle of Grain.

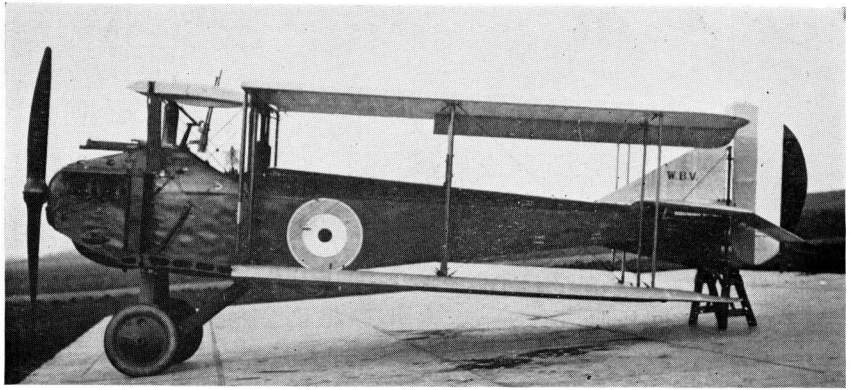


to that of the W.B.IV and was covered with plywood. The engine was in the conventional position, the pilot sat under the centre section, and there was no built-in buoyancy chamber. There were two radiator blocks, one on each side of the fuselage, and the engine had lengthened exhaust stubs to carry the efflux clear of the radiators.

Folding wings were again employed, but on the W.B.V upper and lower mainplanes were of equal chord and there was no stagger. As on the W.B.IV, ailerons were fitted to the upper wings only. The flotation gear, like that of the W.B.III, consisted of inflatable air bags fitted along the underside of the leading edges of the lower wings. The undercarriage was jettisonable.

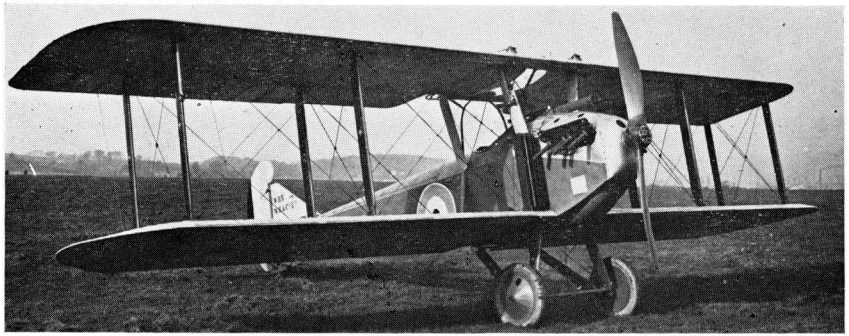
The rudder, tailplane and elevators were very similar to those of the W.B.IV, but both upper and lower fins were extended somewhat. The 37-mm. Puteaux gun was mounted between the cylinder blocks of the engine and fired through the hollow airscrew shaft. This weapon was installed in the first W.B.V but was quickly replaced by a fixed Vickers gun on top of the fuselage; a Lewis gun on a tripod mounting fired vertically upwards through a cut-out in the centre section.

Of the cannon-armed W.B.V its designer, the late G. Tilghman-Richards, wrote: "It was a horrible design as the pilot had to be placed right up against the rear of the breech to load and fire the gun, and it made everything very cramped and horribly dangerous in



The first Beardmore W.B.V, with wings folded

The second W.B.V. N42, at Dalmuir.



case of anything going wrong with the gun breech. It was delivered to the R.N.A.S. and I was told that pilots just refused to pull the trigger, one pilot remarking that he was not going to give an imitation of a squid, propelled backward with his tentacles trailing ahead. It came to nothing."

The first W.B.V was flown at Grain after its conversion to normal armament, but it was damaged beyond repair on 11th January 1918. The second aircraft, N42, was completed in 1918 and flew at Dalmuir on 20th February. On N41, as on the early W.B.III, interplane struts had been fitted at the inboard ends of the mainplanes. These were not fitted to N42, but it had auxiliary struts bracing the lower stub wings to the upper longerons.

No development was pursued, however, and the W.B.V was apparently abandoned before the war ended.

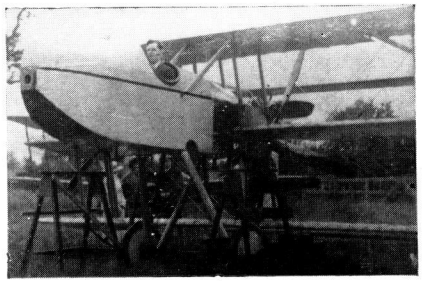
Type: *Single-seat Shipboard Fighter.* **Power:** *One* 200 *h.p. Hispano-Suiza eight-cylinder water-cooled engine.* **Armament:** *Originally one* 37 *mm. Canon Puteaux; later one fixed, synchronized* 0.303-*in. Vickers machine-gun and one* 0.303-*in. Lewis machine-gun on tripod mounting.* **Performance:** *Maximum speed,* 112 *m.p.h. at ground level,* 103 *m.p.h. at* 10,000 *ft. Climb to* 5,000 *ft.,* 6 *min.; to* 10,000 *ft.,* 17 *min. Endurance,* 2½ *hours.* **Weights:** *Empty,* 1,860 *lb.; loaded,* 2,500 *lb.* **Dimensions:** *Span,* 35 *ft.* 10 *in.; length,* 26 *ft.* 7 *in.; height,* 11 *ft.* 10 in.; *wing area,* 394 *sq. ft.*

BLACKBURN TRIPLANE

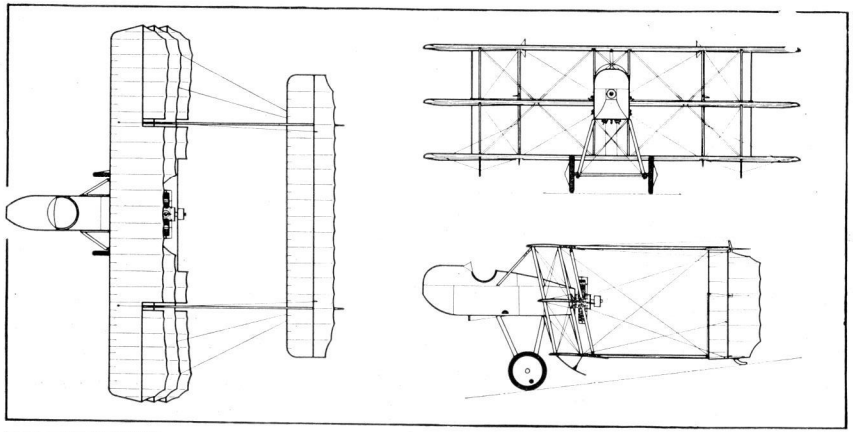
The single-seat triplane fighter built by the Blackburn Aeroplane & Motor Co. Ltd. in 1916 was designed by Harris Booth, who had left the Air Department of the Admiralty to join the Blackburn company. Although rather less bizarre than the A.D. Scout of Booth's design, the Blackburn triplane inherited a number of the Sparrow's characteristic features.

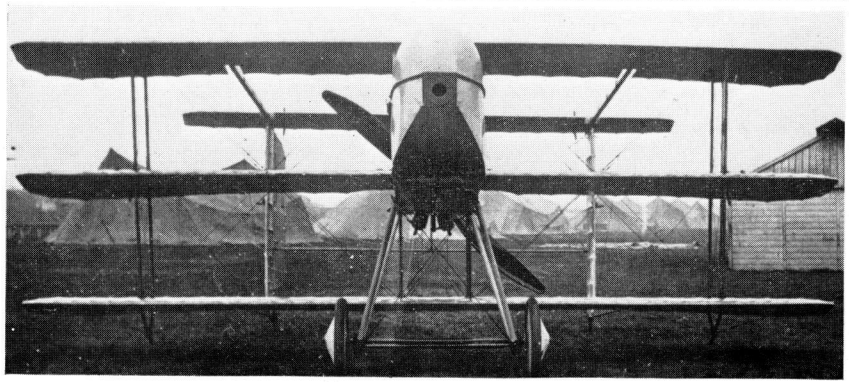
As on the A.D. Scout, the tail booms of the triplane were parallel in plan and side elevation, and the two tall fins and rudders were surmounted by a tailplane of unusually large span; the tail-skids were attached to the lower ends of the rudders. All three mainplanes were of equal span and all had ailerons; the control surfaces were interconnected by wooden strut-like components. The aileron control cables actuated the ailerons on the middle wing. Ground clearance of the bottom wing was small, consequently skids were fitted under the wing tips.

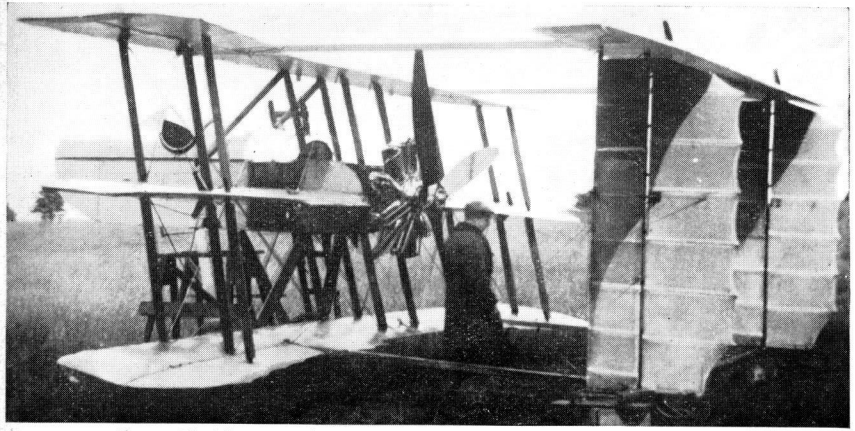
The nacelle was an ugly affair with a long deep nose that must have restricted the pilot's field of view. At the front of the nacelle there was a large orifice that so closely resembled the corresponding part of the A.D. Scout that it is reasonable to assume that, like the Sparrow, the Blackburn Triplane was intended to carry



Blackburn Triplane







Above, Blackburn Triplane with Clerget engine and four-bladed airscrew.
Left, Blackburn Triplane with Monosoupape engine and two-blade airscrew.

a Davis recoilless gun. Sketches depict a Lewis gun mounted on top of the nacelle immediately in front of the cockpit, but it is doubtful whether the triplane was ever armed in this way.

Only one aircraft, N502, was built. It was powered at different times by the 110 h.p. Clerget and 100 h.p. Gnôme Monosoupape rotary engines. It seems probable that the Clerget was the first to be fitted; it drove a four-blade airscrew. The Monosoupape had a two-blade airscrew. Various performance figures have been attributed to the Blackburn Triplane. One source quotes an impossible maximum speed of 115 m.p.h., another gives a speed range of 45 to 100 m.p.h., yet another a range of 53 to 112 m.p.h. It is doubtful whether the aircraft could in fact exceed 90 m.p.h.

The manufacturer's trials are believed to have been flown from York race-course; shortly afterwards the aircraft was sent to Eastchurch, where it was accepted on 20th February 1917. It failed to find favour and was written off as unsatisfactory on 19th March 1917.

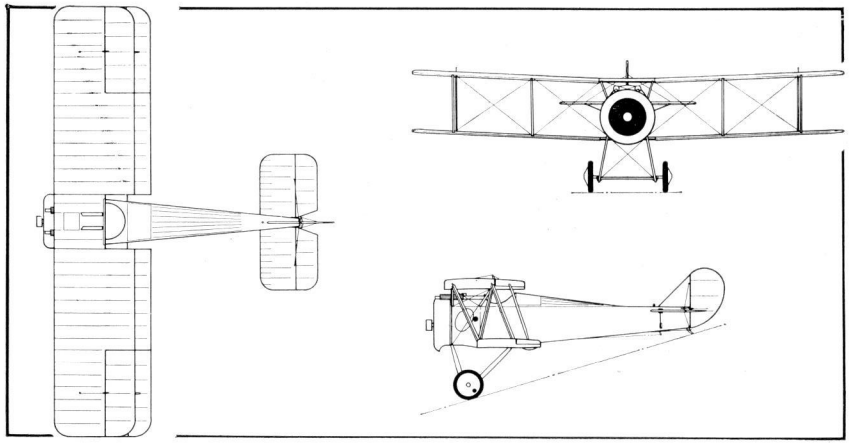
Type: *Single-seat Fighter.* **Power:** 110 *h.p. Clerget 9Z or* 100 *h.p. Gnôme Monosoupape nine-cylinder rotary engine.* **Armament:** *Possibly one Davis recoilless gun.* **Performance:** *No reliable figures available. Endurance,* 3 *hours.* **Weights:** *Empty,* 1,011 *lb.; loaded,* 1,500 *lb.* **Dimensions:** *Span,* 24 *ft.; length,* 21 *ft.* $5\frac{5}{16}$ *in.; wing area,* 221.03 *sq. ft.*

BOULTON & PAUL P.3 BOBOLINK

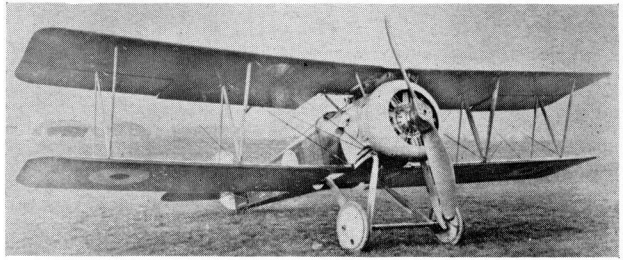
The Norwich company of Boulton & Paul, Ltd., were one of the many firms whose resources and facilities had to be added to those of the infant British aircraft industry soon after the outbreak of war. From making F.E.2b's and 2d's they progressed to Sopwith Camels and became a major contractor for that type.

In 1918 the first aircraft of Boulton & Paul design appeared. Designed by J. D. North, it was a single-seat fighter powered by a 230 h.p. Bentley B.R.2 rotary engine; it bore the Boulton & Paul type number P.3, and was later given the official name Bobolink. The Bobolink was intended to be a replacement for the Sopwith Camel, and was one of two designs prepared by Boulton & Paul. The other was named Hawk but was apparently abandoned in favour of the Bobolink. Three prototypes of each had been ordered; the Hawks would have been C8652–C8654, the Bobolinks C8655–C8657, but only the first Bobolink was completed.

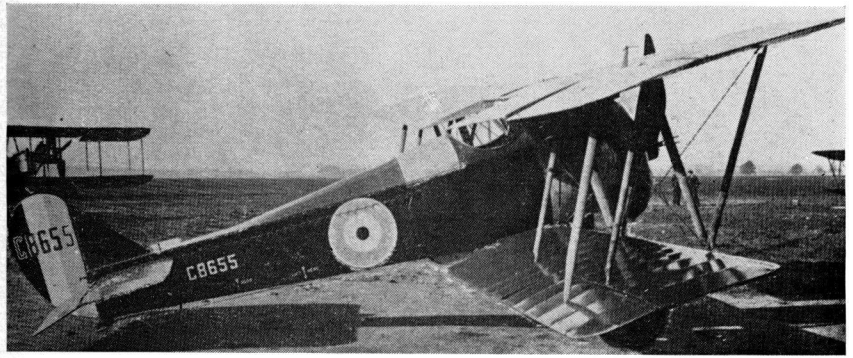
It was a two-bay biplane of good appearance, characterized by N-type interplane struts. The basic airframe was the usual wire-braced wooden structure; it followed contemporary Sopwith practice in general design, and the engine supports were similar to those of the Camel. Armament consisted of two fixed Vickers guns and, in accordance with Air Board specification A.1(a), there was provision for a Lewis gun above the centre section. The fuel tanks, which were immediately behind the cockpit, could be jettisoned in emergency; to this end, connexions to the tanks were made by glass tubing.



Right, The Bobolink as it first appeared, with ailerons on the upper wings only.

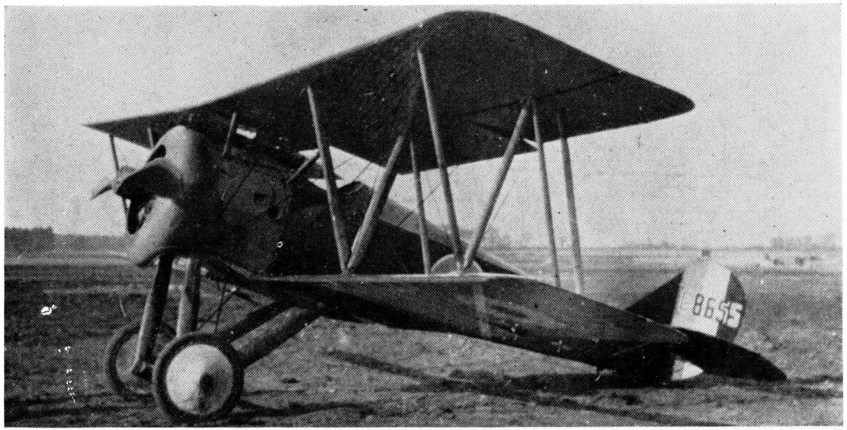


Below, Bobolink at Martlesham Heath, with ailerons on upper and lower wings.



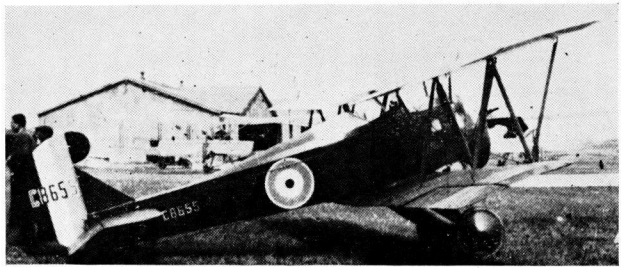
When C8655 first appeared it had ailerons on the upper wings only, but by the time it reached Martlesham Heath ailerons had been added to the lower wings. Upper and lower ailerons were interconnected by strut-like links. Later still these were replaced by cables, by which time the aircraft had an enlarged horn-balanced rudder.

The Snipe was selected as the Camel's successor, and the Bobolink did not go into production. There was little to choose



Bobolink at Martlesham Heath, with ailerons on upper and lower wings.

between the two designs as far as performance was concerned, but the Snipe was regarded as more suitable for mass production. The Bobolink was said to be more difficult to handle on the ground, and it probably gave its pilot a less satisfactory view.



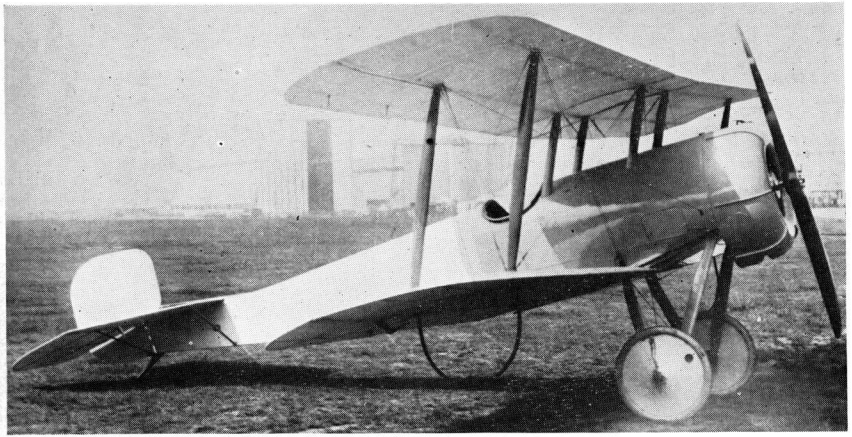
Final form of Bobolink with horn-balanced rudder and cable-connected ailerons.

Type: *Single-seat Fighter.* **Power:** *One* 230 *h.p. Bentley B.R.2 nine-cylinder rotary engine.* **Armament:** *Two fixed, synchronized* 0.303-*in. Vickers machine-guns; there was provision for a semi-free* 0.303-*in. Lewis machine-gun to be carried on the centre section to starboard.* **Performance:** *Maximum speed,* 125 *m.p.h. at* 10,000 *ft.,* 109 *m.p.h. at* 15,000 *ft. Climb to* 10,000 *ft.,* 9 *min.* 20 *sec.; to* 15,000 *ft.,* 18 *min. Service ceiling,* 19,500 *ft. Endurance,* $3\frac{1}{4}$ *hours.* **Weights:** *Empty,* 1,226 *lb.; loaded,* 1,992 *lb.* **Dimensions:** *Span,* 29 *ft.; length,* 20 *ft.; height,* 8 *ft.* 4 *in.; wing area,* 266 *sq. ft.*

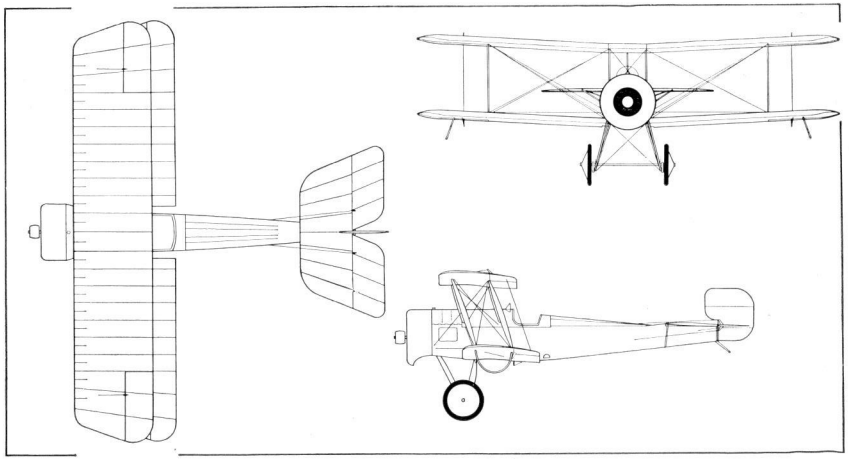
BRISTOL SCOUT B, C, & D

The Bristol Scouts that were quite widely used by the R.F.C. and R.N.A.S. in the early years of the war were descended from a delightful little sporting single-seat biplane that had been designed at the end of 1913 by Frank Barnwell. It was his first original design to be built by the British and Colonial Aeroplane Co. Ltd.

When displayed at the fifth Aero Show, held at Olympia in March 1914, the Bristol created a minor sensation. Even at that early date, when no military application of the aircraft



Bristol Scout B at Farnborough.

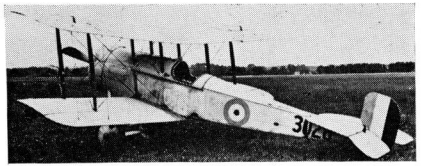


had been considered, it was referred to as the Bristol Scout. It had already attained a speed of 95 m.p.h. in its early trial flights, for which it was flown by Harry Busteed.

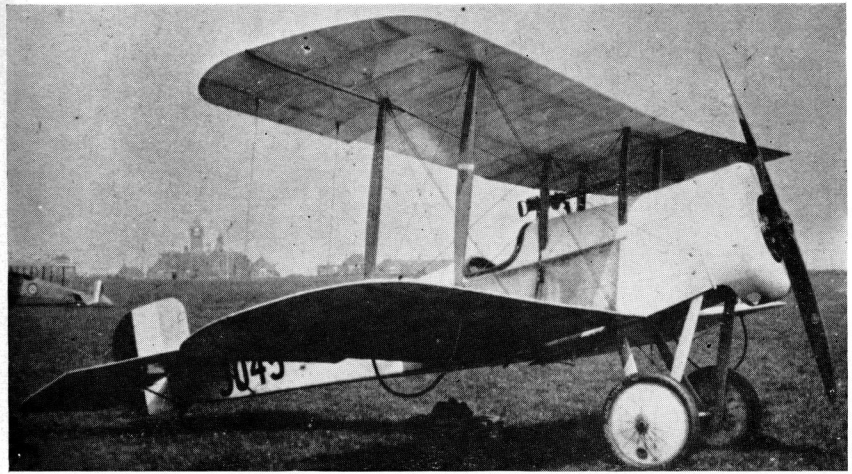
In April 1914 the original 22 ft. wings were replaced by surfaces of greater span (24 ft. 7 in.) and chord. A larger rudder was also fitted, and the 80 h.p. Gnôme engine was given a more conventional cowling with a circular frontal aperture.

The Bristol was entered for the 1914 Aerial Derby but did not participate owing to poor visibility. Shortly afterwards it was bought by Lord Carbery, who fitted an 80 h.p. Le Rhône in place of the Gnôme. His ownership of the Bristol was brief: while competing in the London-Paris-London race on 7th July 1914 he ran out of fuel on his return cross-Channel flight and had to ditch. Lord Carbery was rescued but the aircraft was lost.

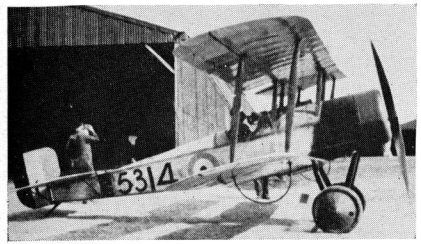
Two further aircraft that were under construction in the summer of 1914 were taken over by the R.F.C. as Nos. 633 and 648 when



Typical Scout C for R.N.A.S. This aircraft, No. 3026, was flown at Chingford.



Scout C No. 3045 of R.N.A.S. Dover, *with fixed Lewis gun.*



Scout C with synchronized Vickers gun.

they were completed: by then Europe was at war. These two aircraft had the 80 h.p. Gnôme engine in a circular cowling of peculiar shape; under-wing skids were fitted to the lower mainplane; and flying wires were duplicated. Both Scouts went to France in September 1914, one to No. 3 Squadron, the other to No. 5 Squadron. The former unit armed its Bristol with two rifles, one on each side of the fuselage, firing at an outward angle to clear the airscrew; No. 5 Squadron fitted one rifle, one pistol, and five rifle grenades.

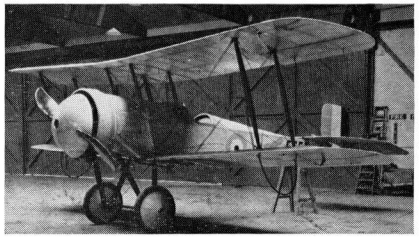
Within the limitations of the aerial warfare of that time, the two Bristol Scouts were successful: although their armament was im-

provised and largely ineffective, combats were rare occurrences and the performance of the Bristols was much superior to that of the opposing aircraft.

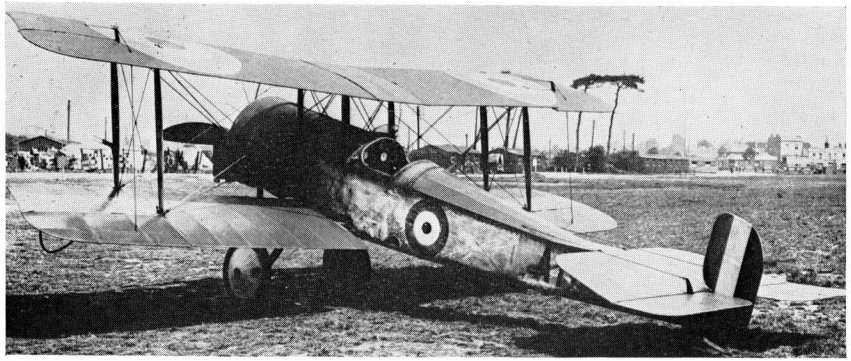
Production orders, modest at first, were placed from November 1914 onwards for the R.F.C. and R.N.A.S. The aircraft built under these contracts were designated Bristol Scout C: retrospectively the original aircraft was named Scout A, its two successors Scout B.

The Scout C was very similar to the Scout B but had a deeper top decking ahead of the cockpit, which was of a different shape, and a revised engine cowling was fitted. The disposition of the plywood and aluminium coverings of parts of the fuselage of the Scout C also differed from that of the Scouts A and B.

When the Bristol Scout went into service with the R.F.C., the operational squadrons were equipped with two-seaters but had one or two single-seat scouts for escort duties. Most of the R.F.C. squadrons in the field therefore had one or two Bristols. On the Bristol Scout of No. 6 Squadron, No. 1611, Captain L. G. Hawker fought the action that won him the



Scout D. No. 5555 with trial installation of 110-h.p. Clerget for M1A monoplane.



Scout D with 80-h.p. Le Rhône engine.

Scout D with synchronized Vickers gun.

V.C. In the course of a single patrol on July 25, 1915, he attacked three separate German two-seaters, shooting down two of them.

With the R.F.C., Bristols continued to be used in this manner until the Battle of the Somme. Although a Bristol Scout was the first British aircraft to go to France equipped with a synchronized machine-gun (on March 25, 1916), no serious attempt to give the Bristol effective armament was ever made. A few examples had a synchronized Vickers gun, but the majority had makeshift arrangements of Lewis machine-guns, rifles or carbines.

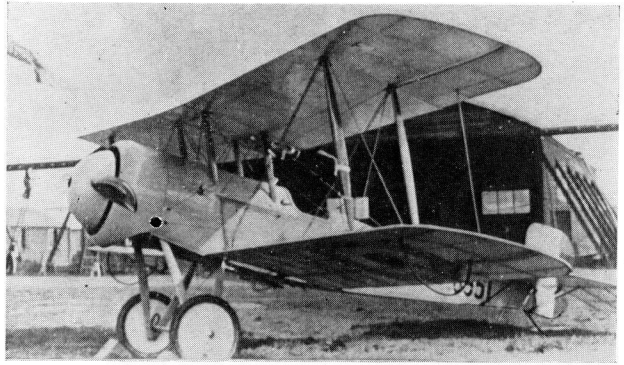
The R.N.A.S. employed its Bristol Scouts as anti-Zeppelin aircraft, mainly from land stations in the U.K. such as Chingford, Dover, Eastchurch, Great Yarmouth, Port Victoria and Redcar. It also sent its Bristols to sea in the hope of intercepting enemy airships: on 3rd November 1915, the Scout C No. 1255 took off from the flying deck of the small carrier H.M.S. *Vindex*. The pilot was Flt-Lt. H. F. Towler; the occasion was the first take-off made by a landplane from a ship under way at sea.

On 2nd August 1916, one of the Bristol Scouts from *Vindex*, flown by Flt-Lt. C. T. Freeman, attacked a Zeppelin. This Scout was armed with Ranken darts (an anti-airship weapon of doubtful efficacy) and failed to destroy the Zeppelin.

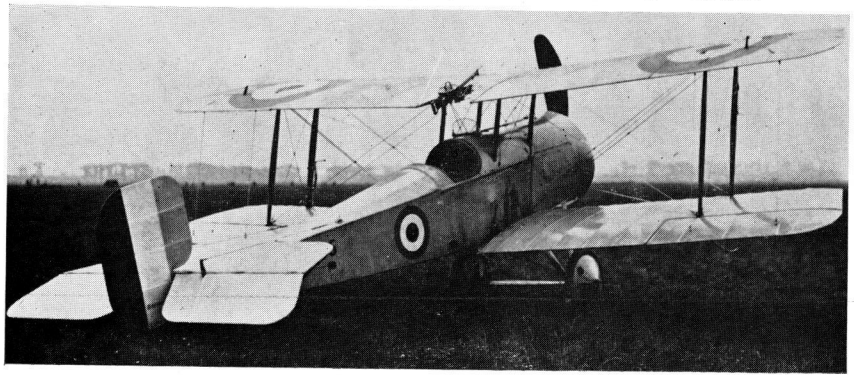
In another attempt to prolong the Bristol Scout's endurance for anti-airship duties, one (No. 3028) was air launched from a Porte Baby flying boat. Although the experiment was successfully performed on 17th May 1916, it was never repeated.

During the second half of 1915 Gnôme

Bristol Scout D. No. 8951 with 100-h.p. Gnôme Monosoupape and large spinner.



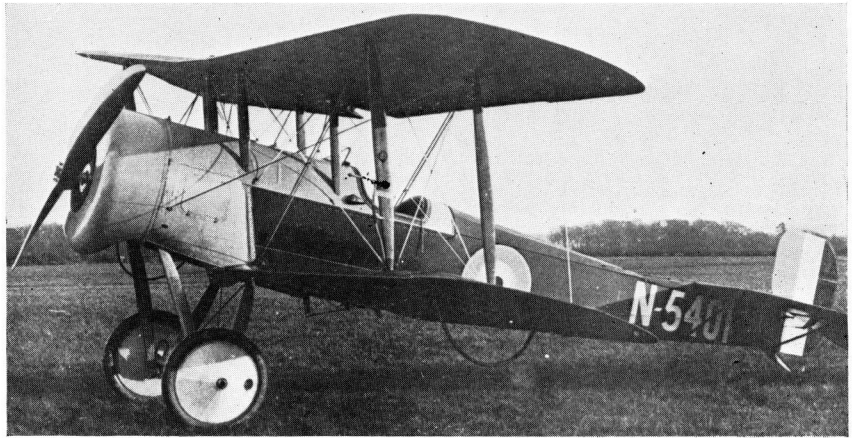
Scout D (Monosoupape) with final, large rudder and over-wing Lewis gun.



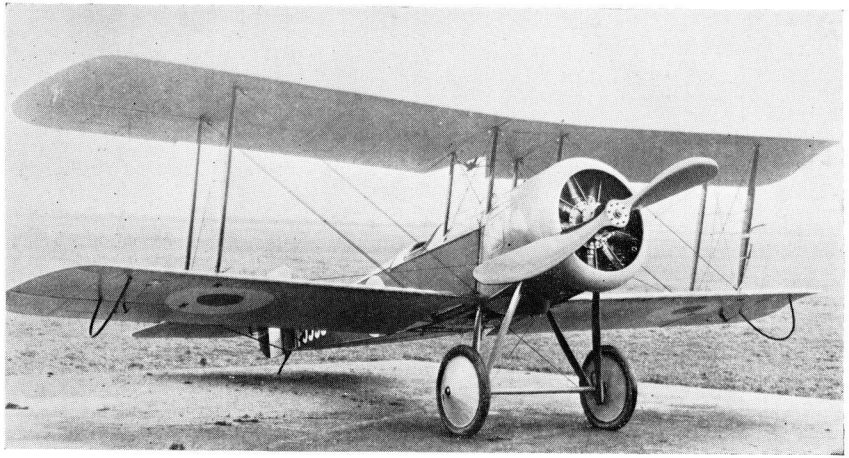
engines became scarce, consequently many Bristol Scouts had to have the 80 h.p. Le Rhône, a few the 80 h.p. Clerget. At first the available Gnômes were reserved for Bristol Scouts built for the R.N.A.S. A new oil system, with the tank in front of the cockpit instead of behind, had to be installed because the Le Rhône's oil pump was less efficient than that of the Gnôme.

The production aircraft that had this modification were designated Bristol Scout D. Deliveries, starting at No. 5554, begun in February 1916. Most of those delivered to the R.F.C. ultimately had the 80 h.p. Le Rhône, but the 100 h.p. Monosoupape was specified for the fifty machines (8951–9000) ordered for the R.N.A.S. It seems likely that some of the R.N.A.S. Scouts had other engines. Of the final R.N.A.S. batch of thirty (N5390–N5419) only the first ten had the Monosoupape; the remainder had the 80 h.p. Gnôme. Scouts D of the first batch (5554–5603) retained the wings and rigging of the Scout C, but most of the later aircraft had shorter ailerons and increased dihedral, their underwing skids were further outboard, and their rudders were further enlarged.

Bristol Scouts saw service in the Aegean with No. 2 Wing R.N.A.S., and in Palestine with R.F.C. Squadrons Nos. 14, 67 (Australian), and 111. Thirty-two were sent to R.F.C units in the Middle East, but the majority were used for training purposes. Armament varied considerably, especially on



Scout D with 80-h.p. Gnôme.



Scout D, 100-h.p. Gnôme Monosoupape.

the R.N.A.S. Bristols, some of which had fixed Lewis guns firing straight ahead without synchronizing gear of any kind. Pierced airscrews that were still usable were plugged and taped.

The shape of the centre section varied somewhat. A cut-out of some kind was usually made if an over-wing Lewis gun was fitted; in the last production batches of the Scout D it was standardized as a V-shaped notch.

Various experimental installations of engines and armament were made in Bristol Scouts. At least three had the 110 h.p. Clerget engine with large spinners; of these, No. 5555 acted as a flying test-bed for the engine installation for the Bristol M.1A monoplane, having the engine that had previously been fitted to one of the S.2A two-seat scouts. The Scout D No. 8951 had a smaller but similar spinner with its 100 h.p. Gnôme Monosoupape.

Lt. Frank Courtney flew a Scout D that had been fitted with the 110 h.p. Le Rhône and large spinner of a Morane-Saulnier monoplane. This was an unofficial modification.

The dwindling number of Bristol Scouts were used for training purposes long after they were withdrawn from operational use. Such was their declared employment, but in fact they were appropriated by senior officers as their personal aircraft, for their delightful flying qualities made them much sought after. A few went to the R.N.A.S. Flying School

at Vendôme, one to Australia, one to the U.S.A.

Lack of adequate armament prevented the Bristol Scout from making a name for itself as a fighter early in the war. It will probably never be known why more active steps were not taken to equip more Bristols with interrupter gears once they became available.

Type: *Single-seat Scout.* **Power:** Scout B, *One* 80 *h.p. Gnôme seven-cylinder rotary engine*; Scout C, 80 *h.p. Gnôme*, 80 *h.p. Le Rhône 9C nine-cylinder rotary engine*, 80 *h.p. Clerget seven-cylinder rotary engine.* Scout D, 80 *h.p. Le Rhône 9C*, 80 *h.p. Gnôme*, 100 *h.p. Gnôme Monosoupape*, 110 *h.p. Clerget 9Z nine-cylinder rotary engine.* **Armament:** *Various arrangements and combinations of pistols, rifles, carbines,* 0.303-*in. Lewis machine-guns, duck guns, and grenades. Some R.N.A.S. Scouts had two* 24-*round canisters of Ranken Darts. A few aircraft had a single synchronized* 0.303-*in. Vickers machine-gun.* **Performance** (*with Le Rhône engine*): Scout C, *Maximum speed*, 92.7 *m.p.h. at ground level*, 86.5 *m.p.h. at* 10,000 *ft. Climb to* 5,000 *ft.*, 7 *min.*; *to* 10,000 *ft.*, 21 *min.* 20 *sec. Service ceiling*, 15,500 *ft. Endurance*, 2½ *hours.* Scout D, *Maximum speed* 100 *m.p.h. at ground level*, 86 *m.p.h. at* 10,000 *ft. Climb to* 10,000 *ft.*, 18 *min.* 30 *sec.* **Weights** (*with Le Rhône engine*): Scout C, *empty*, 757 *lb.*; *loaded*, 1,195 *lb.*; Scout D, *empty*, 760 *lb.*; *loaded*, 1,250 *lb.* **Dimensions:** *Span*, 24 *ft.* 7 *in.*; *length*, 20 *ft.* 8 *in.*; *height*, 8 *ft.* 6 *in.*; *wing area*, 198 *sq. ft.*

BRISTOL T.T.A.

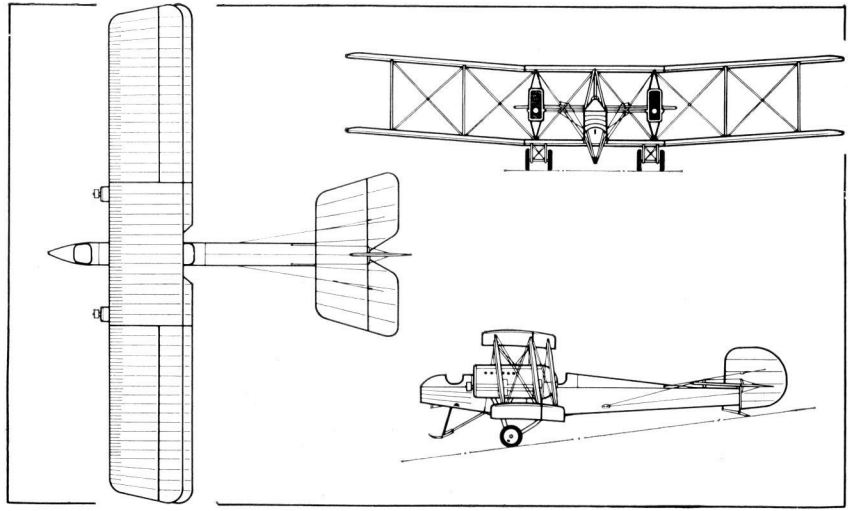
When the war was a few months old, the Filton and Brislington works of the British & Colonial Aeroplane Co. were fully engaged on the production of B.E.2c's and Bristol Scouts, and no original design work was being done. The firm's team of designers began to disperse: Frank Barnwell was commissioned in the R.F.C., and Clifford Tinson joined the Air Department of the Admiralty.

By August 1915 aerial combats were becoming increasingly frequent and the need for fighting aircraft was daily growing greater. Frank Barnwell was released on indefinite leave and returned to the British & Colonial company. With L. G. Frise as his assistant he set about establishing a new design organization at Filton.

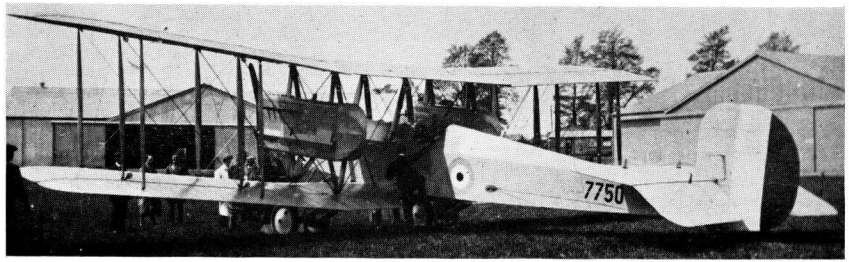
The first new type to be designed, in September 1915, was a large twin-engine biplane that was intended to be a two-seat fighter. It now seems curious that such a large and cumbersome aircraft was designed when the company was already building the nimble Scouts C and D which, with real armament, could have been excellent fighters. At the time, of course, fighting tactics and the characteristics of fighting aircraft had not been established, and, in the absence of a British gun-synchronizing mechanism, a twin-engine aircraft probably seemed to offer a reasonable prospect of success as a gun platform with good performance.

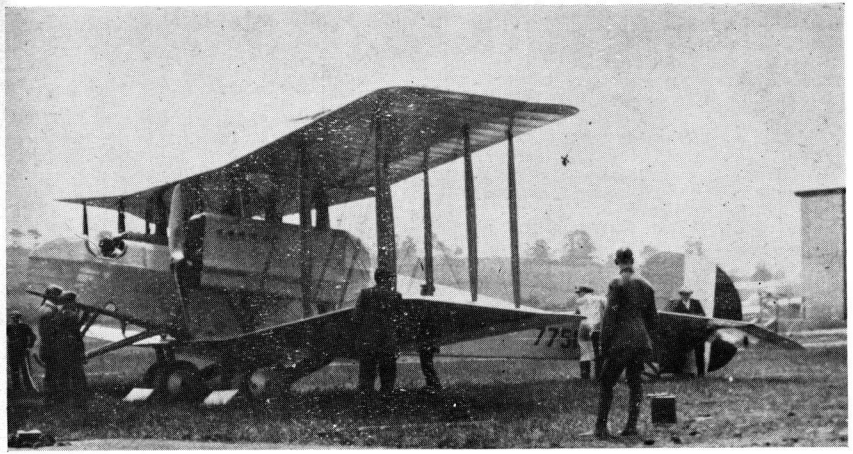
Designated Bristol T.T. (signifying Twin Tractor), the new design was intended to have two 150 h.p. R.A.F. 4a engines. The aim was to produce a compact aircraft with the smallest possible fuselage, but inevitably the T.T. proved to be comparatively large.

The fuselage was deep but narrow. The gunner's cockpit was in the nose, whence he had a good field of fire for his Lewis gun. He had five spare drums of ammunition, and his



The first Bristol T.T.A., No. 7750.





The second aircraft, No. 7751.

cockpit contained a dual set of flying controls. The pilot sat behind the wings, and there was provision for him to have a Lewis gun mounted to fire aft; he had three spare ammunition drums. The main fuel tanks were in the fuselage between the cockpits.

Twin undercarriage units were fitted, one under each engine. The engines were mounted in mid gap at the ends of the centre sections; the mainplanes were of equal span and chord and had unusually large ailerons. A balanced rudder was employed.

After the T.T. design was submitted for approval it was learned that all R.A.F. 4a engines would be required for B.E.12s. The Bristol was therefore redesigned to have two Beardmore engines of 120 h.p. or 160 h.p. Ultimately two 120 h.p. Beardmores were fitted; these engines were opposite-handed and were enclosed in bulky nacelles that obscured a considerable part of the pilot's field of view. In this modified form the design was named Bristol T.T.A.

Two prototypes, numbered 7750 and 7751, were built. They were tested at Central Flying School in May 1916, when they proved to have a somewhat indifferent performance. The T.T.A. earned adverse criticism because the pilot's view from the cockpit was poor, rearward-firing armament could not be effectively installed, there could be no communication between the pilot and gunner, the

fuel system was not satisfactory, and lateral control was poor.

By this time, fortunately, British gun-synchronizing mechanisms were available and the need for aircraft like the T.T.A. disappeared. The big Bristol was therefore abandoned.

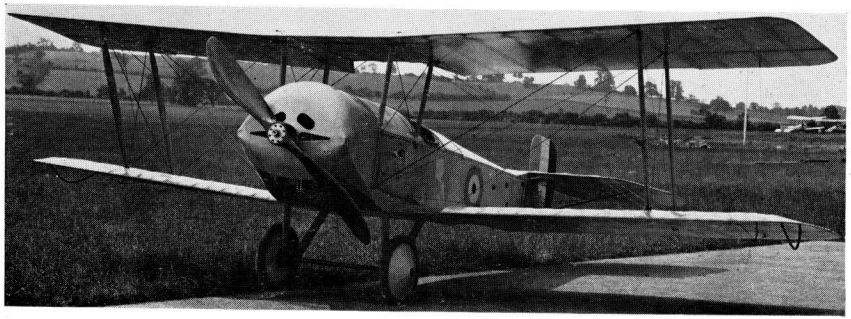
A development was projected as the Bristol F.3A. This was designed for a single Rolls-Royce engine and was intended to be an escort fighter like the Armstrong-Whitworth F.K.12, Sopwith LRTTr and Vickers F.B.11. The Bristol F.3A would have had the wings, tail-plane and rear fuselage of the T.T.A. Two gunners' nacelles were mounted on the upper wing, each with two Lewis guns and ten drums of ammunition. The F.3A's under-carriage anticipated latter-day ideas, consisting of a central unit and a small wheeled skid at each lower wing tip.

Type: *Two-seat Fighter.* **Power:** *Two* 120 *h.p. Beardmore six-cylinder water-cooled engines.* **Armament:** *Two free* 0.303-*in. Lewis machine-guns, one fired by the observer, the other by the pilot.* **Performance:** *Maximum speed,* 86.7 *m.p.h. at ground level,* 85.6 *m.p.h. at* 6,000 *ft. Climb to* 6,000 *ft.,* 21 *min.; to* 10,000 *ft.,* 53 *min.* 15 *sec. Service ceiling* 9,500 *ft.* **Weights:** *Empty,* 3,820 *lb.; loaded,* 5,100 *lb.* **Dimensions:** *Span,* 53 *ft.* 6 *in.; length,* 39 *ft.* 2 *in.; height,* 12 *ft.* 6 *in.; wing area* 817 *sq. ft.*

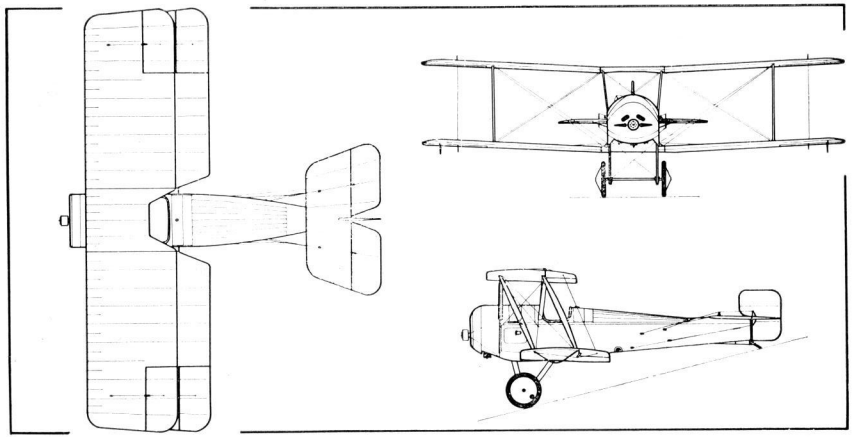
BRISTOL S.2A

The Bristol T.T.A. had represented one attempt to produce an aircraft from which a machine-gun could be used effectively; the Bristol S.2A was another, quite different, approach to the same problem.

Little more than half the size of its twin-engine predecessor, the S.2A was virtually a two-seat version of the Scout D with side-by-side seating. It was designed to meet an Admiralty requirement for a two-seat fighter. Two prototypes, 3692–3693, were ordered but were wisely abandoned in favour of the Sopwith 1½-Strutter. The War Office thought the S.2A might make a good trainer, however, and two aircraft, 7836–7837, were built for the R.F.C.



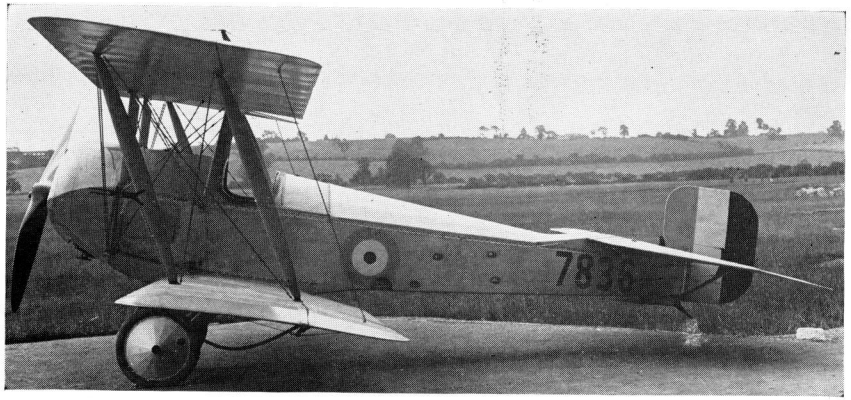
Bristol S.2A.



The wings and tail unit of the Bristol S.2A closely resembled those of the Scout D; the fuselage was considerably wider and the centre section was of correspondingly greater span. The 110 h.p. Clerget was carried in a fore-and-aft mounting with a cowling that resembled that of the Sopwith Tabloid.

The first S.2A was completed in May 1916, by which time, for obvious reasons, it had been nicknamed "Tubby" by the men who had designed and built it. The second emerged in June 1916. The aircraft was quite fast and manoeuvrable, but the Clerget installation proved troublesome at first.

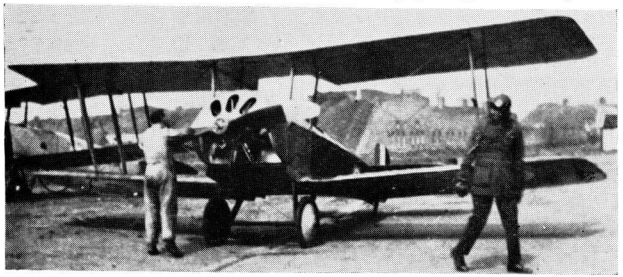
The S.2As were delivered to the Central Flying School in June and July 1916. One was later seen at Gosport with a 100 h.p. Gnôme Monosoupape engine in a modified cowling, and it appears that one was flown as a trainer at Rendcombe in 1917. The machine used at Rendcombe seems to have been known as the Sopwith Sociable, possibly because the Bristol S.2A bore some resemblance to the original Sopwith Tabloid. Some members of the R.F.C. referred to the S.2A more pungently as "the pregnant Bristol".



Bristol S.2A.

Neither of the S.2As seems to have survived the Armistice. At Filton, Frank Barnwell had moved on to much greater things.

Bristol S.2A with 100-h.p. Gnôme Monosoupape engine at Gosport.

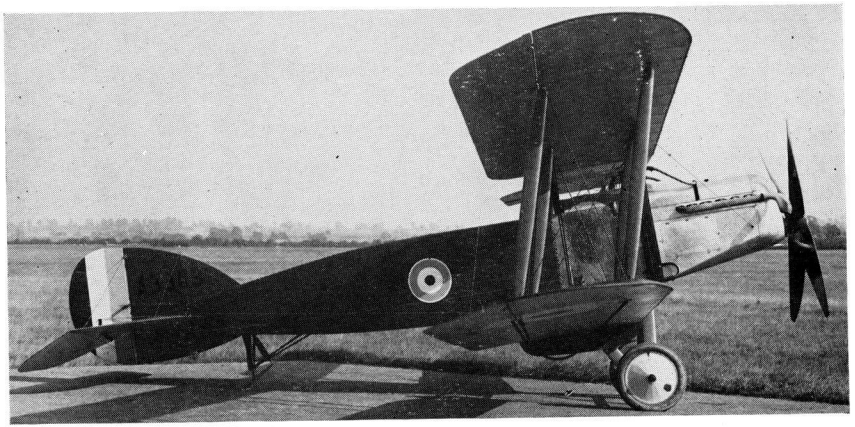


Type: *Two-seat Scout.* **Power:** *One* 110 *h.p. Clerget* 9*Z*, 100 *h.p. Gnôme Monosoupape nine-cylinder rotary engine.* **Armament** (*proposed*)**:** *One* 0.303-*in. Lewis machine-gun.* **Performance:** *Maximum speed,* 95 *m.p.h. No further details available.* **Weights:** *Loaded,* 1,400 *lb. No further details available.* **Dimensions:** *Span,* 28 *ft.* 2 *in.; length,* 21 *ft.* 3 *in.; height* 10 *ft.*

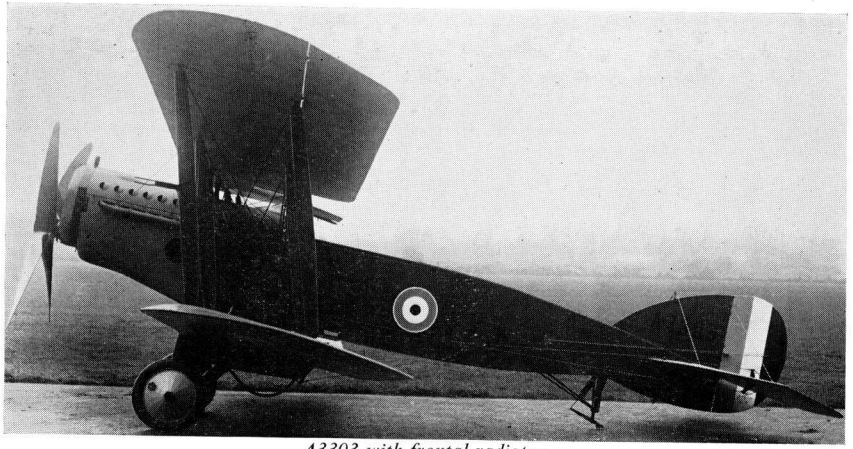
BRISTOL F.2A

The aircraft that was to become one of the immortals of the first war in the air, the Bristol Fighter, had its origins in a design that was intended to compete with the Royal Aircraft Factory R.E.8 as a replacement for the B.E.2c and 2e. Declining an official contract for 200 R.E.8s, the British & Colonial Aeroplane Company proceeded to design a two-seat reconnaissance aeroplane that would have a performance comparable with that of the R.E.8 but none of the official design's defects.

In March 1916 the Bristol R.2A was designed by Frank Barnwell. This was a light two-seater, powered by a 120 h.p. Beardmore engine, with two-bay wings of equal span (40 ft. 8 in.). As soon as details of the new 150 h.p. Hispano-Suiza engine became available Barnwell designed a further type, the R.2B, for the French engine. Although generally similar to the R.2A, the new design was smaller and had unequal-span wings (upper 39 ft., lower 27 ft. 9 in.). Both designs brought the crew close together, the pilot in front with a fixed, forward-firing (and presumably synchronized) Lewis gun on the starboard side, the observer behind with a free Lewis gun on a ring mounting. The significant features of these designs were the placing of the fuselage midway between the mainplanes



The first prototype Bristol F.2A, A3303, with its first radiators.



A3303 with frontal radiator.

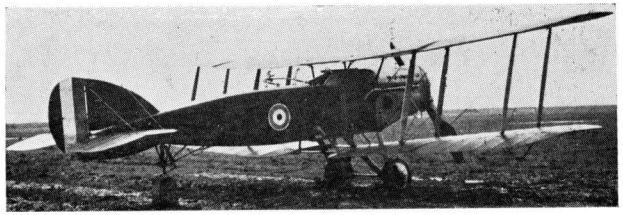
in order to bring the upper wing level with the pilot's eyes, the tapering of the fuselage to a horizontal knife-edge at the stern, and the graceful curving outline of the vertical tail surfaces. It was intended to provide a form of emergency dual control for the observer, and there was a device for adjusting the tail-plane incidence in flight.

When the 190 h.p. Rolls-Royce engine, later to become renowned as the Falcon, became available, Barnwell recognised in it the ideal power unit for his new two-seater, abandoned the R.2A and R.2B schemes, and designed a completely new aircraft. This was designated F.2A, the change of prefix letter evidently signifying a shift of emphasis from reconnaissance to fighting as the aircraft's principal function.

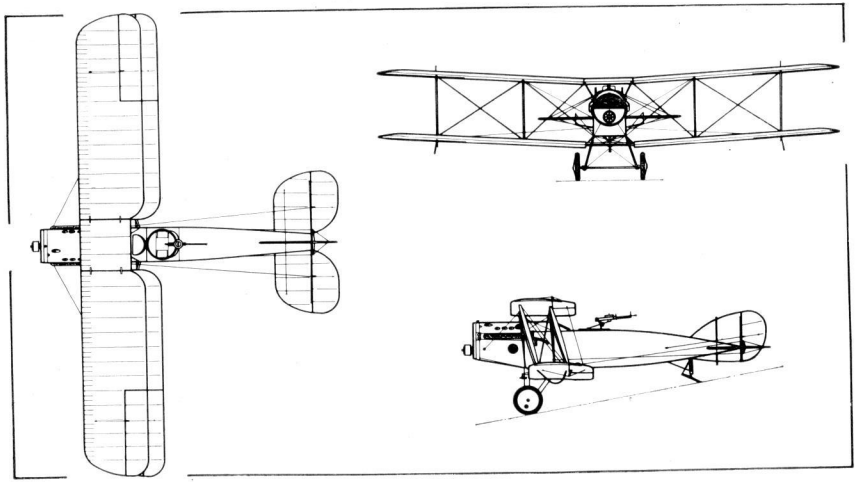
Two prototypes, A3303 and A3304, were built, the former with the 190 h.p. Rolls-Royce Mk I engine, the latter with the 150 h.p. Hispano-Suiza. Both embodied the main characteristics of the R.2A and R.2B, but contours and proportions were improved. The downward curve of the top of the fuselage gave the observer an unusually good field of fire for his Lewis gun. The F.2A had two-bay wings of equal span; on the prototypes the plan-form of the wing tips was similar to that of the B.E.2c, and there were end-plates at the lower wing roots, possibly because the wing anchorage frame was not covered over to form a lower centre section. On both prototypes the pilot's seat was armoured.

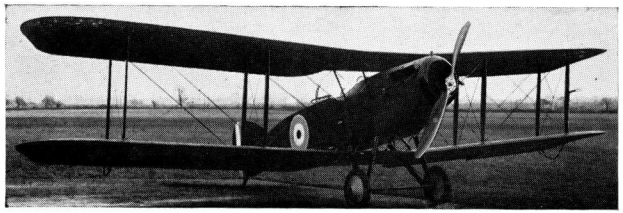
Work on the construction of the prototypes began in July 1916; A3303 was ready for flight

on 9th September, A3304 on 25th October. In its original form the first Bristol F.2A had two tall side radiators, one for each bank of cylinders, and a pylon-type tail-skid. The second prototype had a circular frontal radiator immediately behind the airscrew, the pilot's cockpit had only a small opening, and its tail-skid was built into the base of the rudder. On its first flight A3303 was flown by Captain Hooper, an R.F.C. pilot who did most of the Bristol company's test flying at that time.



A3303 at Orfordness with Scarff ring on the rear cockpit.



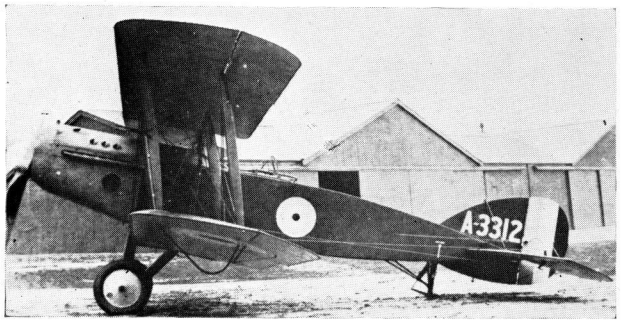


The second F.2A prototype, A3304, with fuselage and lower centre section modified to F.2B standard.

It was found that the side radiators on A3303 interfered with the pilot's view, consequently they were replaced by a single frontal radiator. A new engine cowling and revised exhaust manifolds were fitted; at a later stage the end-plates were removed from the lower wing roots.

Both prototypes exceeded their estimated performance, and fifty aircraft, numbered A3305–A3354, were ordered. These production F.2As were to have Rolls-Royce engines and were to be generally similar to A3303. The wing tips were given a revised plan-form, and the engine cowling was improved and simplified. The engines of production F.2As drove right-hand airscrews: that of A3303 had been left-handed. No armour was provided for the pilot's seat on production aircraft.

The designed armament was a single Vickers gun mounted under the cowling on the aircraft centre line, and a Lewis gun on a Scarff ring mounting on the observer's cockpit. A special tunnel had to be made through the upper petrol tank to accommodate the Vickers gun. With armament installed and a two-blade airscrew replacing its original four-blader, A3303 went to the armament experimental unit at Orfordness for further testing. By this time the shape of the front of the pilot's cockpit had been modified. The modifications to A3304 are described in the article on the Bristol F.2B.



Production F.2A with cambered cowling round radiator.

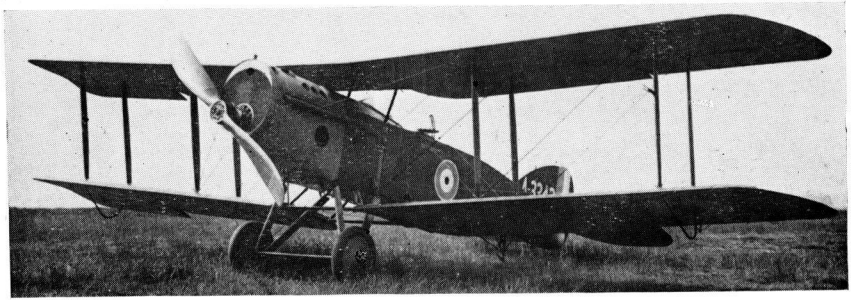
Pilots with operational experience who flew the F.2As reported enthusiastically on them. In November 1916 Sir Douglas Haig ordered the training and equipment of two F.2A squadrons in readiness for the 1917 spring offensive. To derive the maximum advantage from the surprise effect expected from such a weapon, the aircraft's use was to be restricted until the opening of the Battle of Arras.

The first R.F.C unit to be equipped with the new Bristol two-seaters was No. 48 Squadron, which arrived in France on 8th March, 1917. In preparation for the Battle of Arras, which was due to start on 9th April, the air offensive opened along the entire British front five days earlier. Six of No. 48 Squadron's aircraft made their first offensive patrol on 5th April, led by Captain W. Leefe Robinson, V.C. Near Douai they were attacked by six Albatros D.IIIs of *Jagdstaffel* 11, led by Rittmeister Manfred, Baron von Richthofen. Only two Bristol F.2As returned to No. 48 Squadron's aerodrome at Bellevue.

This fiasco, which cast doubt on the usefulness of the Bristol two-seaters, occurred because the pilots flew them in what was then the orthodox manner for two-seaters (namely, as a platform for the observer's gun), and because there was a belief, completely unfounded, that the Bristol F.2A suffered from certain structural weaknesses and could not be thrown about with safety.

After other early failures, pilots came to realise that the F.2A's main weapon was the Vickers gun, the rear Lewis being largely a means of tail protection. On 30th April, 1917, six Bristols were able to fight their way back from Douai without loss. A combat technique was then developed from this discovery, and the Bristol, in its F.2B form, went from strength to strength, to win recognition as one of the greatest aircraft of its day.

After their withdrawal from front-line service the surviving F.2As continued to be used for experimental and training purposes. One was fitted with an experimental device,



A3343 with radiator cowling removed. Of No. 48 Squadron, this F.2A was shot down by Manfred von Richthofen on 5th April 1917

apparently for anti-airship duties, that automatically aligned the observer's gun or guns with an upward-looking gun-sight mounted on the centre section at an angle of 45° above the horizontal. This was doubtless one of the series of Orfordness experiments that led to the standardization of the 45° sight on Home Defence Bristol F.2Bs.

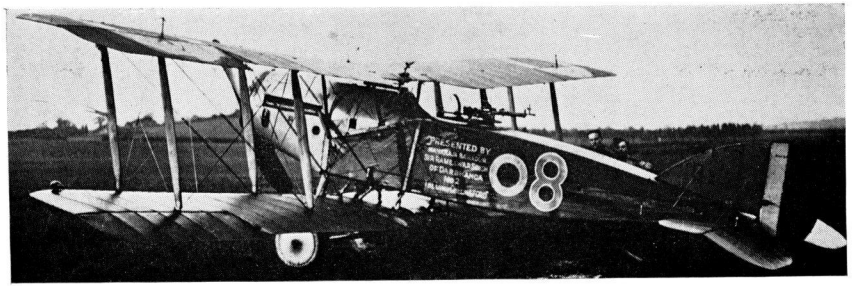
Type: *Two-seat Fighter-reconnaissance.* **Power:** *One* 190 *h.p. Rolls-Royce Mk I (Falcon I) twelve-cylinder water-cooled engine*; 150 *h.p. Hispano-Suiza eight-cylinder water-cooled engine.* **Armament:** *One fixed* 0.303-*in. Vickers machine-gun, one* 0.303-*in. Lewis machine-gun on Scarff ring mounting on rear cockpit.* **Performance** (*A3303, at* 2,753 *lb.*): *Maximum speed,* 110 *m.p.h. at ground level*; 106 *m.p.h. at* 5,000 *ft.*; 96 *m.p.h. at* 15,000 *ft. Climb to* 5,000 *ft.*, 5 *min.* 25 *sec.; to* 10,000 *ft.*, 14 *min.* 30 *sec.; to* 15,000 *ft.*, 31 *min. Service ceiling,* 16,000 *ft. Endurance,* 3¼ *hours.* **Weights** (*production F.2A*): *Empty,* 1,727 *lb.*; *loaded,* 2,667 *lb.* **Dimensions:** *Span* (*prototypes*), 39 *ft.* 2½ *in.*; (*production*), 39 *ft.* 3 *in.*; *length* (*Falcon*), 25 *ft.* 9 *in.*; (*Hispano-Suiza*), 24 *ft.* 10 *in.*; *height,* 9 *ft.* 4 *in.*; *wing area,* 389 *sq. ft.*

BRISTOL F.2B

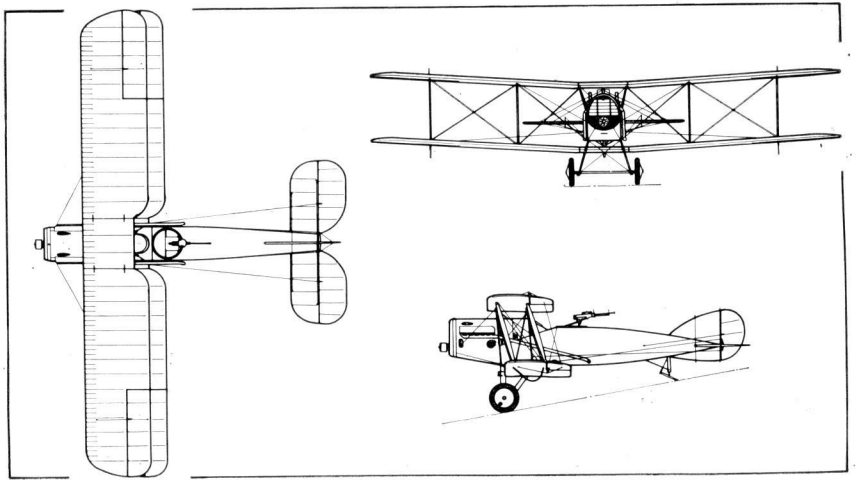
Official confidence in the Bristol two-seater was restored once its combat technique had been established. Orders under the original contract were progressively augmented until a further 550 (A7101–A7300, B1101–B1350, C4801–C4900) had been ordered by July 1917.

These later aircraft embodied several modifications and were designated Bristol F.2B. The forward and downward view from the pilot's cockpit of the F.2A had been criticized. On the F.2B the upper longerons were given a pronounced downwards slope from the back of the pilot's cockpit to the rear of the engine. This allowed the top decking

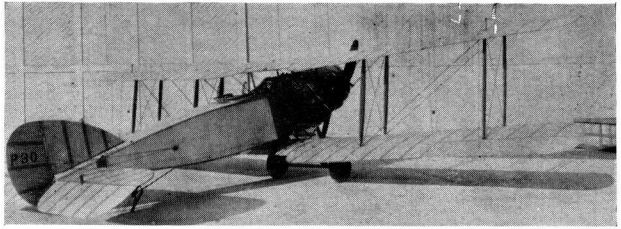
Bristol F.2B, B1145, with four-blade airscrew.



Bristol F.2B of a Home Defence Squadron, equipped for night fighting.



ahead of the cockpit to be tapered upwards, thus improving the pilot's view. It also permitted the introduction of a larger petrol tank and ammunition box for the Vickers gun. The wing anchorage frame of the lower wing was built out to full aerofoil section and covered, thus becoming a lower centre-section plane.



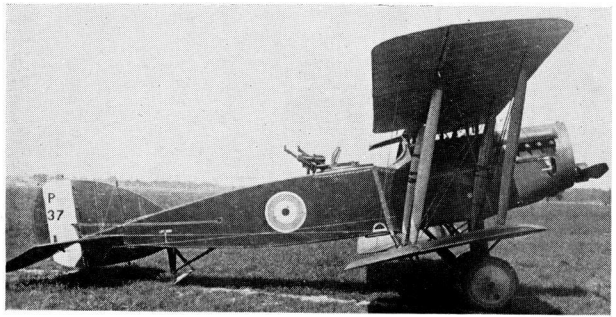
Bristol F.2B P-30 (ex-A7207) with 300-h.p. Hispano-Suiza.

These modifications were first made late in 1916 on A3304, the second F.2A prototype, which retained its original wing-tips, tail-skid, and the 150 h.p. Hispano-Suiza engine. Its radiator cowling had been slightly modified and a Scarff ring-mounting installed by the time it was revised to incorporate the main F.2B characteristics. (See page 100.)

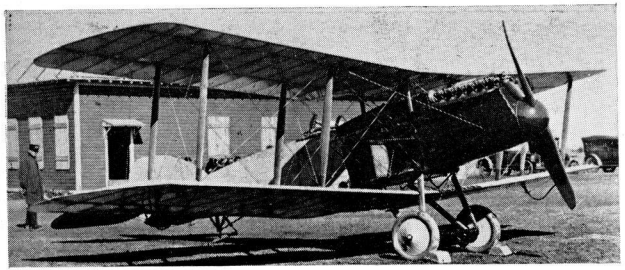
The Bristol F.2B had new horizontal tail surfaces of greater span and higher aspect ratio than those of the F.2A. The first 150 aircraft, A7101–A7250, had the 190 h.p. Rolls-Royce Falcon I engine, with the exceptions of A7177 and A7183 in which, respectively, the first Falcon III and Falcon II installations were made.

Like A7183, the next fifty aircraft (A7251–A7300) were fitted with the 220 h.p. Rolls-Royce Falcon II; apparently this power unit was also fitted to a few later aircraft (e.g., C4808). The great majority of Bristol Fighters were powered by the superb 275 h.p. Rolls-Royce Falcon III, and in this form the aircraft remained in daily use until the armistice — and for many years beyond.

Bristol F.2B (P-37) with 290-h.p. Liberty 8.



The second R.F.C. squadron to have the Bristol Fighter as its equipment was No. 11, which was in the



Curtiss-built Bristol F.2B (U.S.A. O-1) with flank radiators.

process of changing from F.E.2bs to its new mounts in June 1917. By the end of July, No. 22 Squadron had also been re-equipped with Bristols; in September, No. 20 Squadron followed suit.

From the time of its introduction into No. 11 Squadron, the potential of the Bristol F.2B was convincingly demonstrated by a young Canadian officer and his N.C.O. observer. Lieutenant (later Major) A. E. McKeever and Sergeant (later Lieutenant) L. F. Powell were almost certainly the finest two-seater crew of the war. Between 20th June, 1917 and January 1918 McKeever shot down thirty enemy aircraft.

In January and April 1918, squadrons Nos. 62 and 88 went to France equipped with Bristol Fighters, and helped cement the formidable reputation the redoubtable two-seater had acquired. No. 11 Squadron's crews were finding they could not induce the enemy to fight unless their Bristols flew in pairs or singly; no enemy formation would attack a group of three or more Bristols. No other aircraft of any nationality earned quite so much respect from its adversaries, and the last year of the war saw the Bristols victorious in many spectacular combats.

In Palestine, No. 67 Squadron (No. 1 Squadron, Australian Flying Corps) took over the Bristols of No. 111 Squadron and flew the type with great success until the end of the war. From the spring of 1918 until the Armistice No. 139 Squadron flew its Bristols with telling effect in Italy.

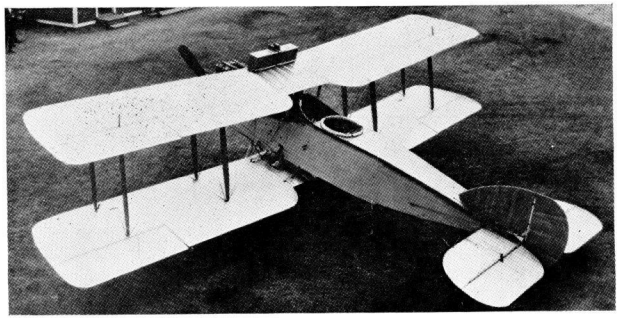
Three Home Defence squadrons (Nos. 36, 39 and 141) were equipped with the Bristol F.2B; other units had a few examples on their strength.

As early as July 1917 it had been decided to re-equip all British fighter-reconnaissance and corps-reconnaissance squadrons with the Bristol F.2B. Orders for the aircraft were substantially increased, and, from November 1917 onwards, Bristols were ordered from several additional contractors. Well over 5,250 Bristol F.2Bs were ordered under war-time contracts; 3,101 had been produced by the end of 1918. Of these, 2,202 were built by the parent company up to 11th November, 1918.

With production planned on such a scale, it was obvious that the supply of Rolls-Royce Falcon engines would not suffice to meet the demand. It was decided that the Falcon-powered Bristols should be allocated to the

fighter-reconnaissance squadrons and that those intended for the corps squadrons should be fitted with alternative engines. This aspect of the development of the Bristol F.2B will be dealt with in the volume dealing with reconnaissance aircraft of World War I.

On 1st August, 1917, General Pershing recommended that the Bristol F.2B should be produced in the United States, powered by the 200 h.p. Hispano-Suiza engine. Two weeks later, A7207, a Bristol F.2B that had seen service with No. 22 Squadron, was shipped to the U.S.A. as a sample aircraft; it arrived at the Smithsonian Institution, Washington, on 5th September, 1917, accompanied by a part-set of design drawings. Colonel V. E. Clark, a member of the Bolling Commission, undertook the task of completing the set of drawings. Unfortunately, he redesigned the aircraft to have the new and untested Liberty 12 engine, a power unit for which the Bristol was quite unsuited. It is not known who authorized this redesign. It was proceeded with despite the strenuous opposition of the British and Colonial Aeroplane Co. Ltd.



U.S.A. O-1 with radiator on centre section.

The U.S. Aircraft Production Board recommended that 1,000 Bristol F.2Bs should be ordered from the Fisher Body Corporation, but at the end of October 1917 this contract was cancelled and the order placed with the Curtiss Aeroplane and Motor Co. On 7th December it was doubled.

The sample F.2B had been sent to Curtiss on 7th November, 1917, and the first Curtiss-built aircraft was completed on 25th January, 1918. Its first flight was made on 5th March, and by 28th March the building of 400 aircraft had been authorized. Unfortunately, by that time Major E. J. Hall of the U.S. Signal Corps had devised so many modifications of the original design that about 1,400 Curtiss production drawings were made obsolete and production delays inevitably occurred. By this time the U.S. version of the Bristol F.2B had been given the designation U.S.A. O-1.

The Liberty 12 installation was bulky and clumsy. The original side radiators obscured the pilot's forward and downward view, and were replaced by a radiator above the centre section.

After three crashes with U.S.A. O-1s (two of which were caused by bad workmanship) an official test of the type produced a substantial list of deficiencies.

In April, 1918 Lt. Col. Vincent, the Chief Engineer, had fitted the sample F.2B, A.7207, with the only specimen of the American-built 300 h.p. Hispano-Suiza engine then in existence. Late in June he sent it to McCook Field, where it flew as P-30. The Air Board instantly recognised the far greater potential of this combination of engine and airframe, and suggested that Curtiss should abandon their Liberty-powered U.S.A. O-1 in favour of a version with the 300 h.p. Hispano-Suiza. To this, the Curtiss company objected strongly but to no avail: the contracts for the O-1 were cancelled on 20th July 1918.

A second sample Bristol F.2B arrived from England on 25th June, 1918. It was engineless, for it was intended to have a 300 h.p. Hispano-Suiza fitted in the U.S.A. It was ultimately flown with the 290 h.p. Liberty 8 engine at McCook Field, with the identity P-37.

The further development of P-30 and P-37 led to the U.S. XB-1 and XB-2, which will be dealt with separately in the U.S.A. volume in this series. It is worth recording here, however, that in spite of all the extensive (and unnecessary) American modifications that were made to the Bristol F.2B design, no American variant was one whit better than Frank Barnwell's original.

In the R.A.F. the Bristol served faithfully until 1932, performing tasks that had not been envisaged when it was first designed. It was one of the greatest aeroplanes of all time.

Type: *Two-seat Fighter-reconnaissance.* **Power:** *One* 190 *h.p. Rolls-Royce Falcon I,* 220 *h.p. Rolls-Royce Falcon II,* 275 *h.p. Rolls-Royce Falcon III, all twelve-cylinder water-cooled engines.* **Armament:** *One fixed* 0.303-*in. Vickers machine gun; one or twin double-yoked* 0.303-*in. Lewis machine guns on Scarff mounting on rear cockpit; up to twelve* 20-*lb. Cooper bombs.* **Performance** (*Falcon III*)**:** *Maximum speed,* 123 *m.p.h. at* 5,000 *ft.;* 113 *m.p.h. at* 10,000 *ft.;* 105 *m.p.h. at* 15,000 *ft. Climb to* 10,000 *ft.,* 11 *min.* 50 *sec.; to* 15,000 *ft.,* 23 *min.* 45 *sec. Service ceiling,* 18,000 *ft.* **Weights** (*Falcon III*)**:** *loaded,* 2,848 *lb. No further details available.* **Dimensions:** *Span* 39 *ft.* 3 *in.; length* 25 *ft.* 10 *in.; height,* 9 *ft.* 9 *in.; wing area,* 405.6 *sq. ft.*

BRISTOL M.R.1

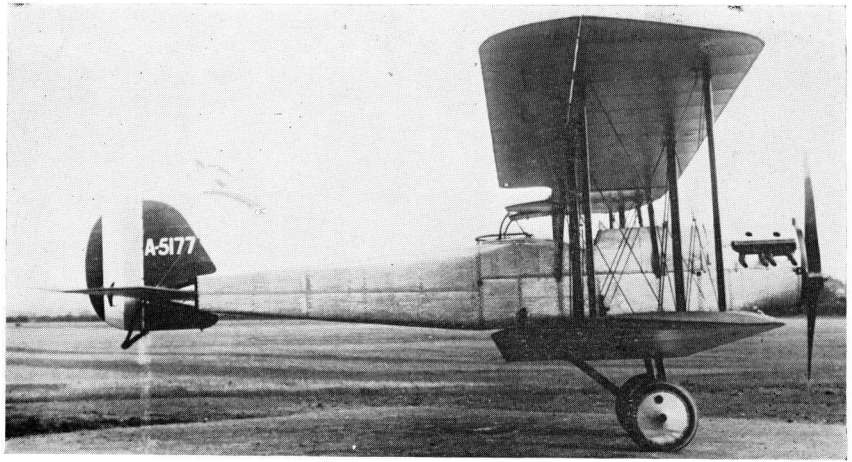
Aircraft with metal airframes had been built before 1916, but metal covering was virtually unknown. It is unlikely that Frank Barnwell had heard of the first Junkers all-metal monoplane by July 1916: the German design had first flown in December 1915.

In May 1916 the British official specification No. 6 was issued, and in July Barnwell made the first design sketches for a two-seat biplane intended to fulfil the requirement. He handed these sketches over to W. T. Reid, who developed them into the design that became the Bristol M.R.1. Two prototypes, A5177 and A5178, were built under Contract No. 87/A/865.

The M.R.1 was a two-bay biplane with unstaggered wings. Its fuselage, like that of the Bristol F.2A/F.2B, was carried in midgap; and, as on the F.2A, the lower mainplanes were attached to an open wing anchorage frame.

The fuselage was a stressed-skin structure without longitudinal members. It had transverse frames of channel-section steel, and the sheet covering was stiffened locally with corrugated aluminium riveted to the inside of the skin. The whole fuselage was made in four separate sections that were bolted together.

The structure of the fabric-covered wings was conventional but was to be executed in steel; their manufacture was entrusted to the Steel Wing Co. of Cheltenham. The anchorages of the bracing wires and their turnbuckles were carried internally, a somewhat



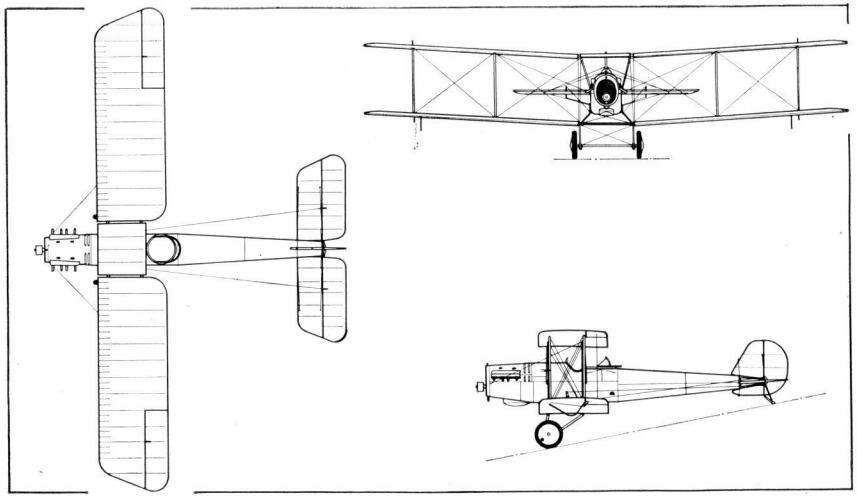
The first Bristol M.R.1, A5177.

unusual refinement. All interplane struts were of steel tubing of streamline section.

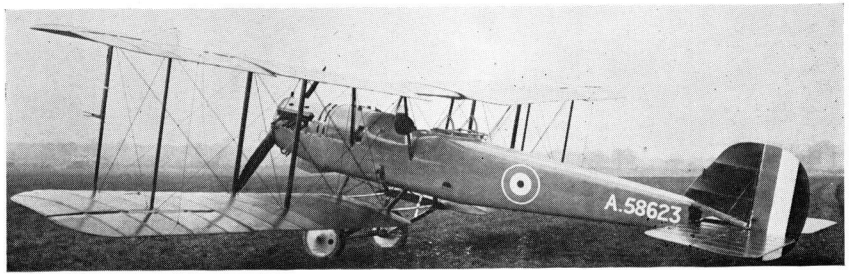
As on the Bristol F.2A and F.2B, the observer's cockpit was immediately behind the pilot's. The crew's field of view was much more limited than on the earlier design, however, for the pilot was situated under the upper wing.

A 150 h.p. Hispano-Suiza engine was allotted for A5177 on 16th May, 1917, and the aircraft flew that summer. The Steel Wing Co.'s metal wings had not been passed for flight, consequently A5177 was flown with conventional wooden wings that had been designed and built at short notice. Ailerons were fitted to the upper mainplanes only. The first M.R.1 still had its wooden wings when it was officially handed over to the Air Board on 23rd October, 1917. It was intended to fit wings built of aluminium on the Mayrow system, but it is not known whether this was done. The ultimate fate of A5177 is uncertain, but it seems likely that it was broken during the strength tests to which it was subjected at the R.A.E., Farnborough, in May 1918. A steel wing of the Krieger type, designed for the M.R.1, had been tested at the R.A.E. in the preceding month.

Work on the second aircraft may have been delayed pending the outcome of the R.A.E. tests, for its engine installation was not started until June 1918. It emerged as A5178 later that year, powered by a Wolseley Viper engine and fitted with steel wings. The second M.R.1



M.R.1 with ailerons on both upper and lower wings.



had ailerons on all four wings; they were of shorter span than those of A5177. There were also detail differences in the engine installation and cowling.

The M.R.1 was not greatly liked by the pilots at Filton, and after the Armistice its delivery was not a matter of urgency. Captain Barnwell took advantage of these circumstances to use the aircraft as a personal hack until it was decided to send the M.R.1 to the Royal Aircraft Establishment. Barnwell flew it there personally on 9th April, 1919, but while approaching to land he struck a pine tree at Farnborough's North Gate and crashed. The M.R.1 was wrecked.

Only the manufacturer's performance figures for the type have survived; they were good, especially in view of the low-powered engine fitted to the aircraft, but not good enough to meet the combat needs of 1918. There were several other reasons why the M.R.1 was not produced, chief among which was the adequacy of the Bristol F.2B, which could be produced easily and quickly by the wood-working aircraft industry of the time.

Type: *Two-seat Fighter-reconnaissance.* **Power:** *One* 150 *h.p. Hispano-Suiza,* 200 *h.p. Wolseley W.4A Viper, both eight-cylinder water-cooled engines.* **Armament:** *One fixed* 0.303-*in. Vickers machine-gun under cowling; one* 0.303-*in. Lewis machine-gun on Scarff mounting on rear cockpit.* **Performance:** *Maximum speed,* 110 *m.p.h. at ground level,* 106 *m.p.h. at* 5,000 *ft.,* 98 *m.p.h.* at 10,000 *ft. Climb to* 5,000 *ft.,* 8 *min.; to* 10,000 *ft.,* 20 *min.* **Weights:** *Empty,* 1,700 *lb.; loaded,* 2,810 *lb.* **Dimensions:** *Span,* 42 *ft.* 2 *in.; length,* 27 *ft.; height,* 10 *ft.* 3 *in.; wing area,* 458 *sq. ft.*

BRISTOL M.1A, 1B & 1C

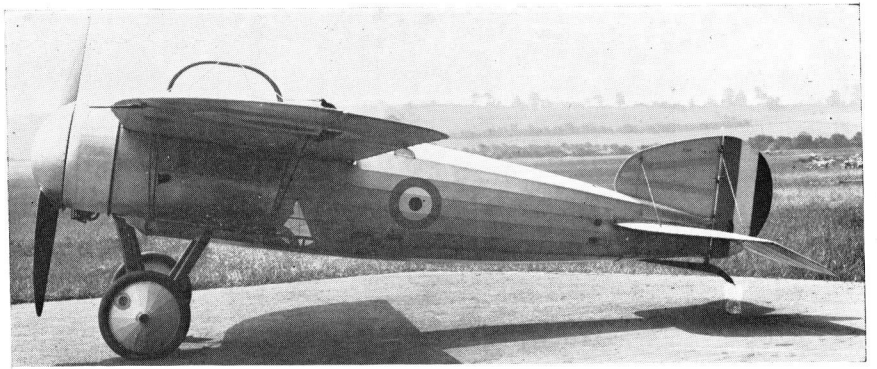
Frank Barnwell was quick to realise that speed would be essential in fighting aircraft. Soon after the Battle of the Somme began he started work on a high-performance single-seater.

For manoeuvrability and lightness he chose a rotary engine and designed for it a low-drag installation, incorporating a large-diameter spinner, that was tested on the modified Bristol Scout D, No. 5555. Having established the practicability of this, he proceeded to design a fully faired fuselage of good streamline form that blended with the circular engine cowling. The basis of this fuselage was a conventional wire-braced box girder with wooden longerons and spacers. Formers and stringers provided the faired contours.

To the upper longerons were attached a pair of monoplane wings. These were braced by cables, the flying wires being anchored to the lower longerons, the landing wires to a cabane structure that consisted of two flattened half-hoops of steel tubing. Lateral control was by ailerons, and a conventional tail unit and simple V-type undercarriage completed the aircraft, which was designated Bristol M.1A.

The adoption of the monoplane layout was an imaginative and bold decision. It gave the pilot an unsurpassed field of view in all vital directions. And yet the prejudice created by the infamous "monoplane ban" of 1912 still existed in Britain, and Barnwell must have known that his new fighter would be viewed with great suspicion.

Proof of the M.1A's quality was provided by its attainment of a speed of 132 m.p.h. in the course of its trial flights, made by F. P. Raynham in the summer of 1916. It underwent official trials at Central Flying School, Upavon, in July 1916, when its maximum recorded speed was 128 m.p.h. at 5,400 ft. and the time to climb to 10,000 ft. was 8 min. 30 sec. The test report, No. M.21, included the following



Bristol M.1A.

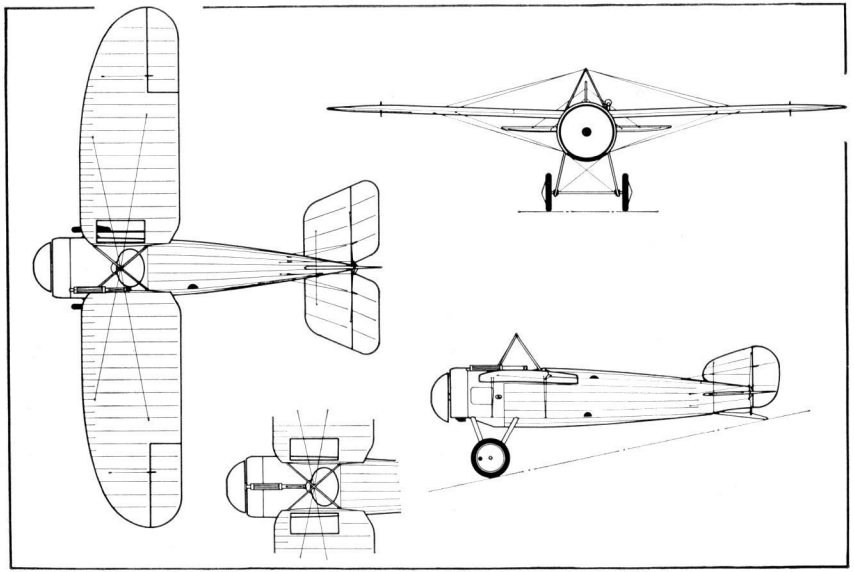
observations, some of them a little surprising: "Stability—lateral very good; longitudinal fairly good; directional good. Machine tiring to fly. Requires good pilot. Moderate ease of landing. Machine trims at 95–105 m.p.h. with engine all out at 8,000 ft. Machine is nose heavy when gliding. Tendency to turn to right with engine on." The stalling speed was recorded as 50–52 m.p.h., the take-off run as 85 yards.

Contract No. 87/A/61, dated 9th October, 1916, gave the M.1A the serial number A5138 and called for four further aircraft, to be numbered A5139–A5142.

These later prototypes were designated M.1B and differed from the M.1A in several details. A simple pyramidal cabane of four straight steel tubes replaced the two half-hoops of the M.1A; a single Vickers gun was mounted on the port upper longeron; and a cut-out was made in the starboard wing root between the spars in order to give the pilot some downward view. Less obvious was the provision for the installation of the 110 h.p. Le Rhône as an alternative to the Clerget. The third M.1B was fitted with a 130 h.p. Clerget, the fourth with the new 150 h.p. A.R.1 engine; the recorded performance with the A.R.1 was disappointing and no development ensued.

The third and fourth aircraft, A5141 and A5142, were sent to the Middle East in June 1917, presumably for Service evaluation trials. It is known that A5142 was attached to No. 111 Squadron, at which time its Vickers gun was mounted centrally on top of the fuselage, the breech mechanism being partly enclosed in a fairing that also served as a windscreen.

Rumours of the Bristol monoplane's outstanding performance had reached the R.F.C. squadrons in France, and the arrival of the production aircraft was eagerly awaited by



the hard-pressed pilots. They never came. For reasons still to be adequately explained, only 125 were ordered, and the handful that were flown operationally were used only in the Middle East. It was said that the landing speed of 49 m.p.h. was too high for the small fields that had to serve as aerodromes in France.

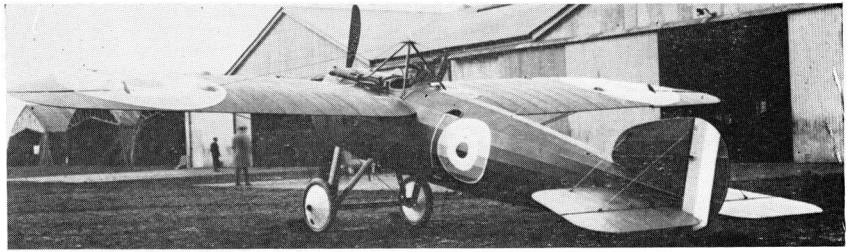
The production version of the type was designated M.1C. It was powered by the 110 h.p. Le Rhône engine, for which the central hole in the spinner was slightly enlarged. The gun was mounted centrally, much as on A5142, and a clear-view cut-out was made in the port wing root to give the pilot downward vision on both sides.

Official statistics indicate that one Bristol monoplane went to France in 1917, but it is not known whether it was an M.1B or an M.1C. Certainly the only operational aircraft of the type were the two M.1Bs and some of the thirty-three M.1Cs that were sent to the Middle East in 1917 and 1918. The two

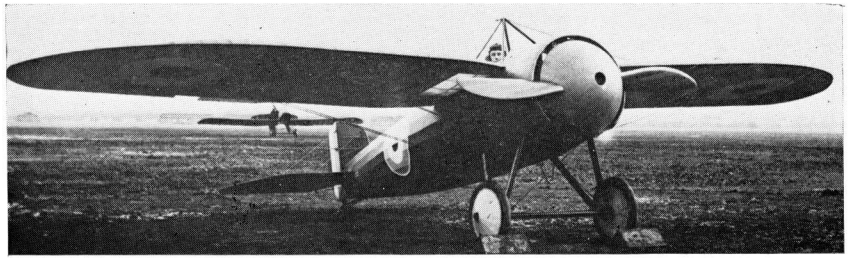
M.1Bs were the only Bristol monoplanes to see service in Palestine. According to the official history, they "had some usefulness in that they made it a little more difficult for the enemy airmen to reconnoitre, except from great heights, but their very limited endurance prevented them from being used to escort the long distance strategical reconnaissance aeroplanes."

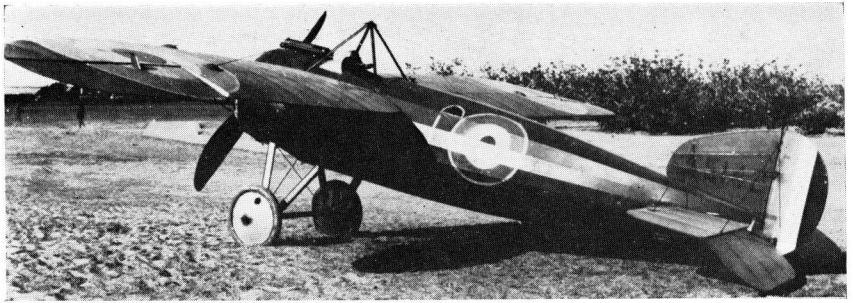
In Mesopotamia, 'C' Flight of No. 72 Squadron flew M.1Cs from Mirjana in March 1918. Two of them won a unique and bloodless victory: a display of aerobatics so impressed some Kurds that their entire tribe gave their allegiance to the British. No. 72 Squadron's Bristol monoplanes later did good work, mainly in the ground-attack rôle, in the capture of Kifri and Kirkuk, and, in October, when co-operating with Brigadier-General A. C. Lewin's force in Kurdistan.

A few M.1Cs were used in Macedonia by Squadrons Nos. 17 and 47; some of these aircraft were subsequently passed on to No. 150 Squadron when it was formed at Salonika



The first Bristol M.1B, A5139.

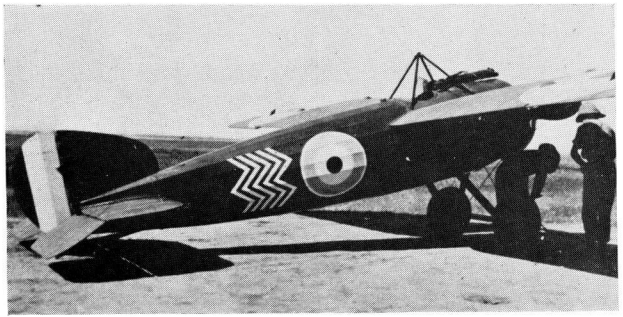




The fourth M.1B, A5142, with centrally-mounted Vickers gun.

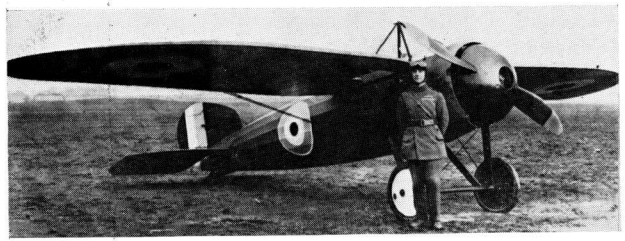
on 1st April, 1918. One was shot down into Lake Dojran on 3rd September, and by the 18th of that month No. 150 Squadron's equipment was listed as S.E.5a's and Camels only. Two M.1Cs were still recorded as on charge in Macedonia on 31st October, however.

It thus seems that fewer than twenty Bristol monoplanes saw operational service. The remainder of the 78 that were delivered to the R.F.C. were used at training stations in the United Kingdom and at Heliopolis in Egypt. Some were fitted with camera guns; at least one such, at Heliopolis, was flown without its spinner.



Bristol M.1C of No. 72 Squadron, Mesopotamia.

The M.1C seems to have been popular with instructors. Several were used at No. 1 School of Aerial Fighting, Ayr, where they were flown by such distinguished pilots as Captain J. T. B. McCudden, V.C., D.S.O.,



Capt. J. T. McCudden, V.C., D.S.O., M.C., with a Bristol M.1C of No. 1 Fighting School, Turnberry.

M.C., M.M., and Captain G. J. C. Maxwell, M.C., D.F.C., A.F.C. Others were flown at Stonehenge, Marske, Montrose and Hounslow. Several of the M.1Cs used at training stations were given flamboyant colour schemes by their "owners".

Six M.1Cs were given to Chile in 1917 in part payment for two warships, ordered by Chile from British shipyards, that had been taken over by the Royal Navy on the outbreak of war. Had they not gone there they would have been scrapped. This incident seems to epitomize the official attitude to the Bristol monoplane: it was something of an outcast. This in spite of its appraisement by Oliver Stewart: "There seems little doubt that the Bristol Monoplane, although it came out much earlier than the S.E. or the Snipe, was actually superior to both of them in all-round performance and powers of manoeuvre." Yet it seems likely that, of the 125 that were built, a fair number never left their packing cases.

Four were bought back by the makers after the war. One went to Spain as M-AFAA, another to the U.S.A.; a third, with a 100 h.p. Bristol Lucifer radial engine, became the M.1D G-EAVP and survived until June 1923; the last, G-EASR, was withdrawn in 1925. The sole survivor, much modified, is VH-UQI, preserved in Australia. This aircraft's original identity was apparently C5001.

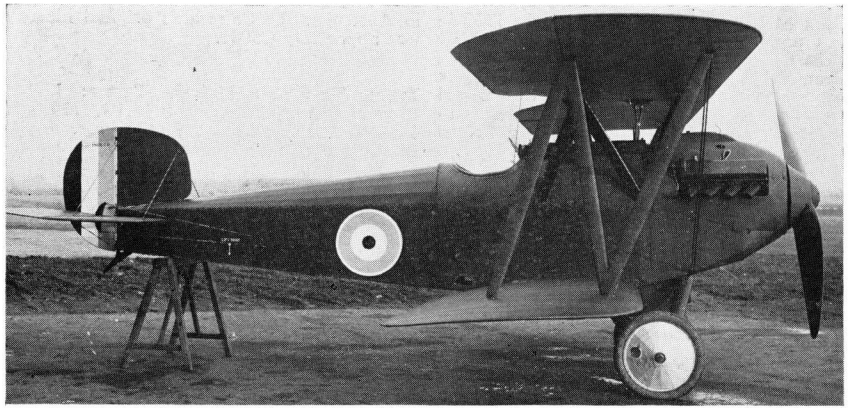
Type: *Single-seat Fighter.* **Power:** M.1A, *One* 110 *h.p. Clerget* 9*Z*; M.1B, 110 *h.p. Clerget*, 130 *h.p. Clerget* 9*B*, 150 *h.p. A.R.*1; M.1C, 110 *h.p. Le Rhône* 9*J*. *All were nine-cylinder rotary engines.* **Armament:** *One fixed* 0.303-*in. Vickers machine-gun on top of fuselage.* **Performance** (M.1C): *Maximum speed,* 130 *m.p.h. at ground level,* 127 *m.p.h. at* 5,000 *ft.,* 111.5 *m.p.h. at* 10,000 *ft. Climb to* 10,000 *ft.,* 10 *min.* 25 *sec. Service ceiling,* 20,000 *ft. Endurance* 1¾ *hours.* **Weights** (M.1C): *Empty,* 896 *lb.*; *loaded,* 1,348 *lb.* **Dimensions:** *Span,* 30 *ft.* 9 *in.*; *length* (M.1C), 20 *ft.* 5½ *in.*; *height,* 7 *ft.* 9½ *in.*; *wing area,* 145 *sq. ft.*

BRISTOL SCOUTS F AND F.1

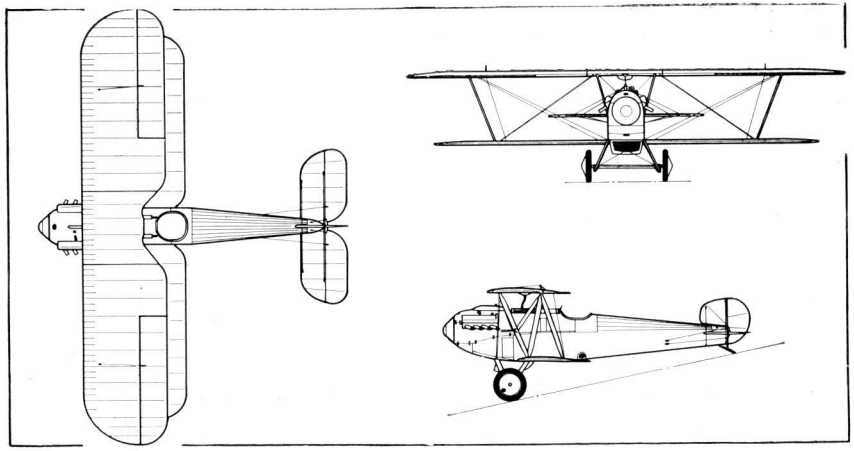
Contemporary with the Bristol M.R.1 was the Scout E project. This was a design for a single-seat fighter powered by a new 200 h.p. water-cooled radial engine, designed by Harry R. Ricardo and Frank B. Halford and known as the Cruciform. The installation envisaged a circular radiator lying immediately behind a large-diameter hollow spinner. The engine was not completed, and the Scout E design was abandoned.

In June 1917 Frank Barnwell began work on the design of the Scout F, another single-seat fighter biplane. It was apparently intended to have the 200 h.p. Hispano-Suiza, but was later re-designed to have the new and untried Sunbeam Arab, doubtless because all available Hispano-Suizas were earmarked for S.E.5a production. The Arab had the same nominal output as the Hispano-Suiza and was also a water-cooled V-eight.

Ordered into large-scale production in January 1917 before it had been adequately tested, the Arab was one of the great mistakes of the war. By May 1917, testing had revealed many weaknesses in the Arab design, but modifications brought some improvement and production proceeded. Many further modifications had to be made, and it was not until the end of 1917 that the Arab's design was finally settled. Of the 1,800 engines that had been expected by the end of that year, only 81 had been delivered.

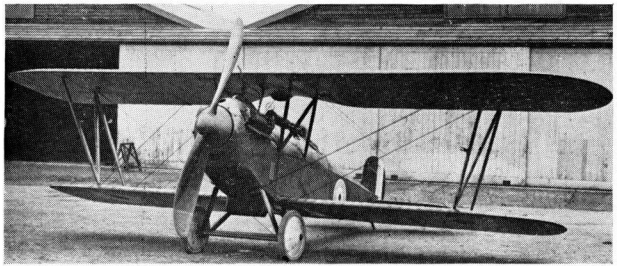


The first Bristol Scout F, B3989.



Bristol Scout F.

The second Scout F.



When the Scout F design was changed to take the Arab, the engine's failings had not been recognised as incurable. Its installation was commendably clean, for an underslung radiator was employed and a large spinner on the airscrew hub blended smoothly with the engine cowling. Rather more than a decade later this type of engine and radiator arrangement became commonplace.

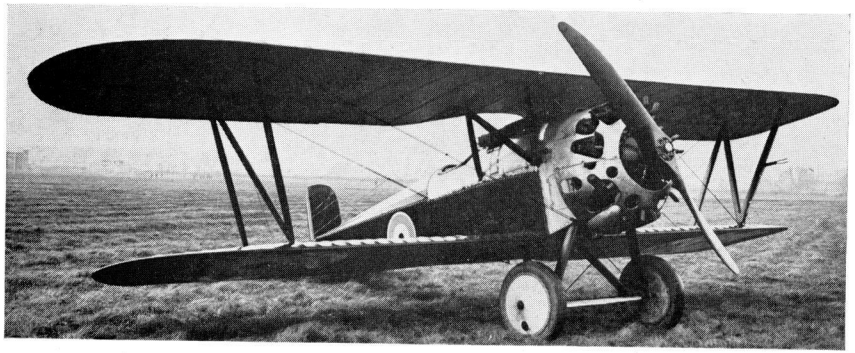
The airframe was conventional in structure. It was distinguished by its N-form interplane and centre-section struts; the mainplanes were of unequal span and chord, ailerons being fitted to the upper wing only. After the care that Barnwell took to place the pilot of the F.2A/2B level with the upper wing it was surprising that the Scout F's pilot sat so low down in relation to its upper mainplane. Nevertheless, Oliver Stewart has recorded that the view from the cockpit was excellent.

Six prototypes, B3989–B3994, were ordered. The first two were fitted with Arab engines and proved to have an excellent performance. The engines were unreliable and vibrated badly: B3990 was still at the R.A.E. Farnborough in July 1919, by which time its engine bearers were reported to be in a very bad condition and had to be reinforced with mild-steel channel strip.

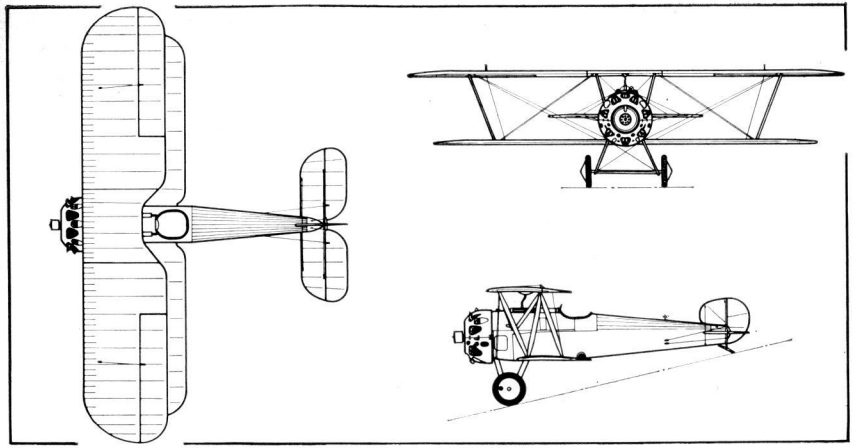
At Martlesham in March 1918 comparative trials were made with and without the spinner. In the spinnerless condition the front of the engine cowling was blanked off with a flat disc; the maximum speed at 15,000 ft. was reduced by 4 m.p.h., and the climbing performance suffered. Earlier, a Scout F flown at Martlesham had been fitted with extended exhaust stubs.

The flying qualities of the Scout F were excellent; although not so instantly agile as the Sopwith Camel it was somewhat more manoeuvrable than the S.E.5a. If it had been fitted with the Hispano-Suiza engine it might have made a considerable name for itself.

In the spring of 1917 the engines section of the Air Board drew up Scheme A, a specification for a radial engine of 42-in. diameter and an output of 300 h.p. This specification exactly fitted the R.A.F. 8 engine; others were designed to meet it by Vickers and Brazil-Straker & Co., Ltd. The latter company's



The Bristol Scout F.1, B3991.



Scout F.1.

engine, designed by L. F. G. Butler under the direction of A. H. R. (now Sir Roy) Fedden, was a fourteen-cylinder two-row radial rated at 315 h.p. and having a maximum output of 347 h.p. It was named Mercury.

Apparently this engine was ordered off the drawing board: a contract for 200 was given to Brazil-Straker in 1917; the engine was not run on the bench until the beginning of 1918. It flew for the first time in April 1918, in the third Bristol Scout F airframe, B3991, which was redesignated Scout F.1. By this time the Brazil-Straker concern had changed hands and had been renamed the Cosmos Engineering Co.

In the Cosmos Mercury installation an attempt was made to minimize the drag of the radial engine by fitting a cowling through which the cylinder heads protruded. The performance of the Scout F.1 was excellent: at ground level its speed was 145 m.p.h. and in April 1919 it climbed to 10,000 ft. in 5.4 minutes and to 20,000 ft. in 16.25 minutes, thereby establishing new records for climbing performance.

By then the Mercury engine had been shelved. The Cosmos company decided in the autumn of 1918 to concentrate on their larger Jupiter nine-cylinder radial, and shortly after the Armistice the Air Ministry cancelled the contract for 200 Mercuries. The Mercury never underwent an official type test (it could in fact deliver its rated 315 h.p. for a short time only); the Scout F.1 was the only aircraft in which it was installed.

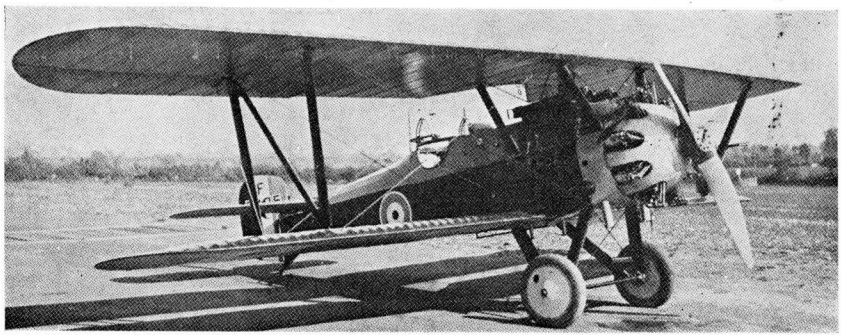
The airframe of the fourth Bristol Scout F, B3992, was built, but was used for structural tests only. These were apparently conducted at Farnborough, the relevant R.A.E. report being dated November 1918.

Type: *Single-seat Fighter.* **Power:** (*Scout F*), *One* 200 *h.p. Sunbeam Arab II eight-cylinder water-cooled engine.* (*Scout F.*1), 347 *h.p. Cosmos Mercury fourteen-cylinder air-cooled radial engine.* **Armament:** *Two fixed* 0.303-*in. Vickers machine-guns on top of fuselage.* **Performance:** (*Scout F*), *Maximum speed,* 138 *m.p.h. at ground level,* 128.5 *m.p.h. at* 10,000 *ft.,* 117.5 *m.p.h. at* 15,000 *ft. Climb to* 10,000 *ft.,* 9 *min.* 20 *sec.; to* 15,000 *ft.,* 17 *min.* 20 *sec. Service ceiling,* 21,000 *ft.* (*Scout F.*1), *Maximum speed,* 145 *m.p.h. at ground level. Climb to* 10,000 *ft.,* 5 *min.* 25 *sec.; to* 20,000 *ft.,* 16 *min.* 15 *sec.* **Weights:** (*Scout F*), *empty,* 1,436 *lb.; loaded,* 2,210 *lb.;* (*Scout F.*1), *loaded,* 2,260 *lb.* **Dimensions:** *Span, upper,* 29 *ft.* 7½ *in., lower,* 26 *ft.* 2 *in.; length,* (*Scout F*), 20 *ft.* 10 *in.,* (*Scout F.*1), 20 *ft.; height,* 8 *ft.* 4 *in.; wing area,* 260 *sq. ft.*

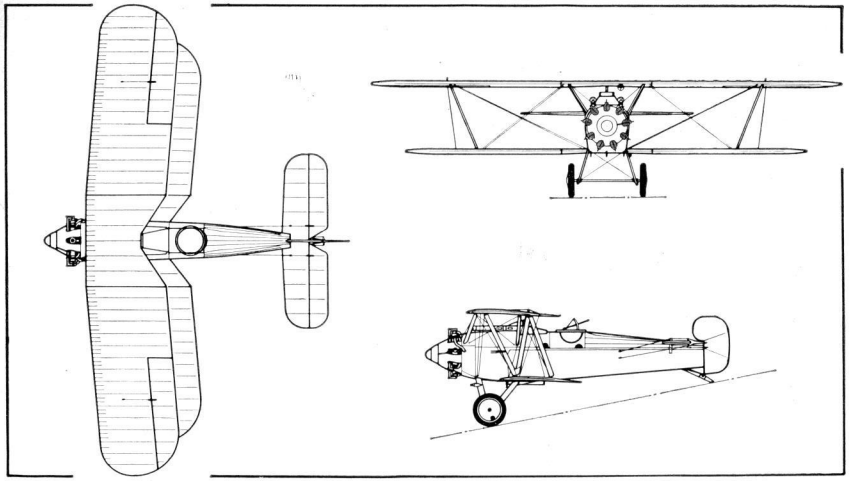
BRISTOL F.2C BADGER

Frank Barnwell had begun to think of a successor to the Bristol F.2B as early as November 1917. He designed a two-seater that was intended to be easily mass-produced; its engine was to be either a 230 h.p. B.R.2 rotary or a 260 h.p. Salmson water-cooled radial. This project was designated Bristol F.2C.

The proposed engines were unable to give the design the necessary performance. It



The first Badger in its original form.



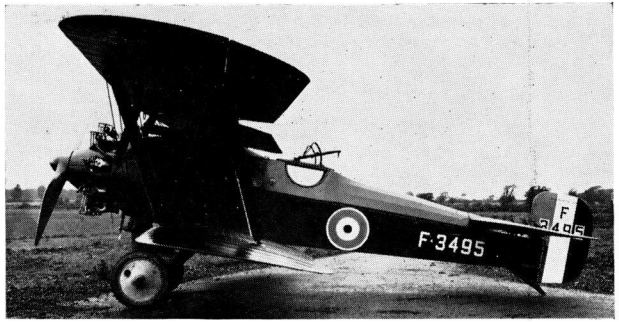
seemed to Barnwell, as it did to so many of his contemporaries, that the new 320 h.p. A.B.C. Dragonfly radial engine held out hopes of greatly improved performance. The new engine was ordered in large quantities in 1918; it was planned that 4,135 Dragonflies would be delivered by June 1919.

For the Dragonfly Barnwell designed a completely new aircraft, which acquired the designation of the abandoned B.R.2/Salmson F.2C. In common with the Austin Greyhound and Westland Weasel, the Bristol F.2C was appropriate to R.A.F. Types IIIa (short-range fighter-reconnaissance) and IIIb (corps aircraft for artillery observation). It was given the official name Badger, and three prototypes (F3495–F3497) were ordered.

The Badger was a single-bay biplane with rather narrow gap and sweep-back on the upper wing. The crew were placed close together, the pilot having twin Vickers guns; the sides of the observer's cockpit were cut away under the Scarff ring to improve his field of view.

By June 1918 the mock-up had been officially inspected, modifications subsequently suggested had been incorporated in the design, and work on the fuselage and mainplanes of F3495 was well advanced. When it first appeared, the aircraft had a hemispherical cowling over most of the engine. At a later stage a revised cowling that exposed more of the cylinders was fitted; in this installation the airscrew was given a small spinner. Cooling

was always a problem with the Dragonfly, but in 1918–1919 it had not been realised that the fault was fundamentally one of bad cylinder design, and no amount of modifications to the cowling could make it satisfactory. At about the same time as the engine cowling was altered, F3495 was fitted with a slightly enlarged rudder. It was still without a fin.



F3495 with modified engine cowling and enlarged rudder.

The first Badger crashed on 4th February 1919 when an air-lock in the petrol feed caused engine failure. By this time it had been realised that the Dragonfly's troubles were serious, but a Badger fitted with that engine underwent official trials at Martlesham in September 1919.

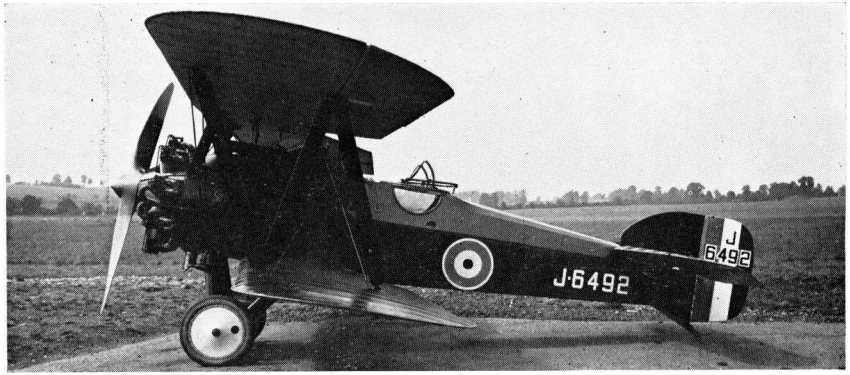
By the autumn of 1918 the Cosmos Engineering Co., Ltd., had decided to stake its future on its new nine-cylinder Jupiter radial engine, designed by A. H. R. Fedden. Soon after the armistice an official development contract for a small number of Jupiters was given, but the company put much of its own money into the venture. The first Jupiter I, a direct-drive engine, was completed in October 1918 and was first run a few days before the armistice.

A Cosmos Jupiter was installed in the second Bristol Badger, F3496, in 1919. Originally this aircraft was flown with the standard armament and equipment, but by June 1919 the form of the engine cowling had been modified, the Vickers guns and Scarff ring removed. and the rear cockpit partly enclosed, its side apertures being glazed over. A low-aspect-ratio fin was fitted, with a plain rudder hinged to it.

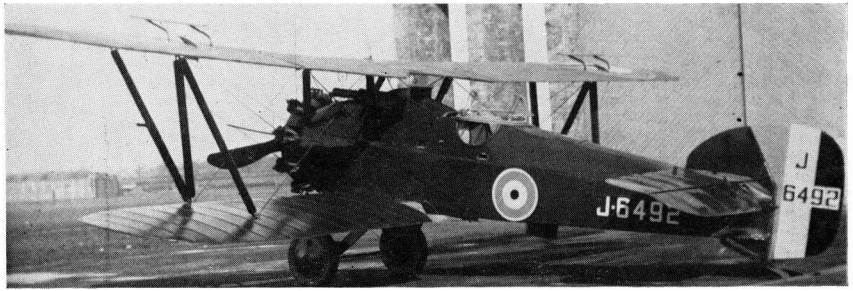
The third Badger of the original prototype batch was not completed in its designed form. Its wings and tail unit were used by Barnwell in his Badger X, which was intended to be a sporting single-seater. It had a Siddeley Puma engine and a redesigned fuselage. The Badger X made its first flight on 13th May, 1919 but, although registered K-110, later G-EABU, it did little flying.

A third military Badger was built, however. This aircraft, J6492, was the true Badger II, powered by a 450 h.p. Cosmos Jupiter I and having full military equipment. Its fin and rudder were originally similar to those of F3496, but at a later stage a balanced rudder was fitted and the ailerons were given aerofoil-type balances. The engine installation was fitted with inter-cylinder baffles.

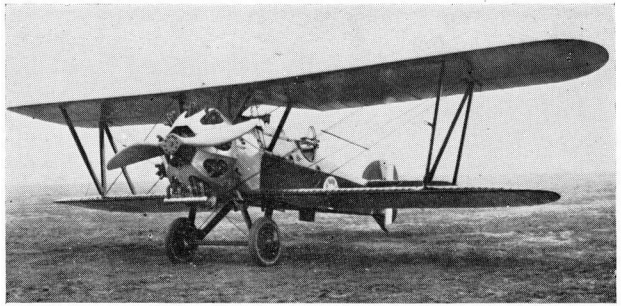
Much valuable development flying was done with the Badger-Jupiter combination. The unexpectedly high cost of developing the engine broke the Cosmos company, which



The third Badger in its original form, with 450-h.p. Cosmos Jupiter 1 engine.



J6492 with balanced ailerons and rudder.



Badger II, J6492, with 385-h.p. Bristol Jupiter II

closed down in February 1920. The Jupiter engine passed the newly-imposed official 50-hour type test (it was in fact the first engine to do so) while the company was in liquidation. Largely as a result of government pressure, the Bristol Aeroplane Co. took over the Cosmos assets and all patents and parts for the Jupiter engine.

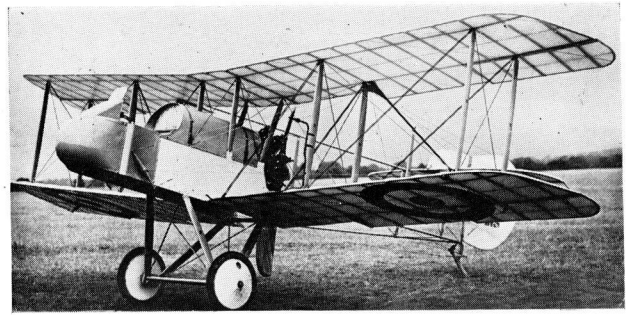
In 1921 the Badger II J6492 was fitted with the 385 h.p. Jupiter II, which had an epicyclic reduction gear and improved valve gear. A cowling of unusual form was fitted, and the armament was removed. In this form J6492 was flown at the R.A.E., Farnborough, and helped to secure the success of the Jupiter II and the future of the Bristol Jupiter series of engines.

Type: *Two-seat Fighter-reconnaissance.* **Power:** *One* 320 *h.p. A.B.C. Dragonfly I*; 450 *h.p. Cosmos Jupiter I*; 385 *h.p. Bristol Jupiter II*; *all were nine-cylinder air-cooled radial engines.* **Armament:** *Two fixed* 0.303-*in. Vickers machine-guns firing forward*; *one* 0.303-*in. Lewis gun on Scarff ring mounting on rear cockpit.* **Performance** (*Badger I*): *Maximum speed*, 135 *m.p.h. at ground level*, 129 *m.p.h. at* 10,000 *ft.*, 122 *m.p.h. at* 15,000 *ft. Climb to* 10,000 *ft.*, 11 *min.*, *to* 15,000 *ft.*, 20 *min.* 30 *sec. With Jupiter I engine the maximum speed at ground level was* 142 *m.p.h.* **Weights** (*Badger I*): *empty*, 1,948 *lb.*; *loaded*, 3,152 *lb.* **Dimensions:** *Span*, *upper* 36 *ft.* 9 *in.*, *lower* 31 *ft.* 4 *in.*; *length*, 23 *ft.* 8 *in.*; *height*, 9 *ft.* 1 *in.*; *wing area*, 357.2 *sq. ft.*

DE HAVILLAND D.H.2

At various times before war began in 1914 several men had foreseen the potentialities of aircraft armed with machine guns. In June 1914 Geoffrey de Havilland joined the Aircraft Manufacturing Co. Ltd. from the Royal Aircraft Factory, bringing with him his knowledge of the designs of the gun-carrying F.E.2a and F.E.6 and of the early experiments with the F.E.3.

For want of a British machine-gun inter-

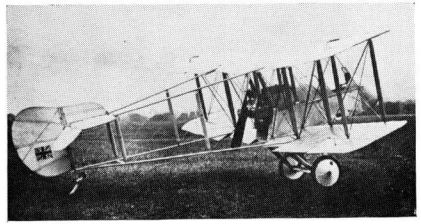


The prototype D.H.2.

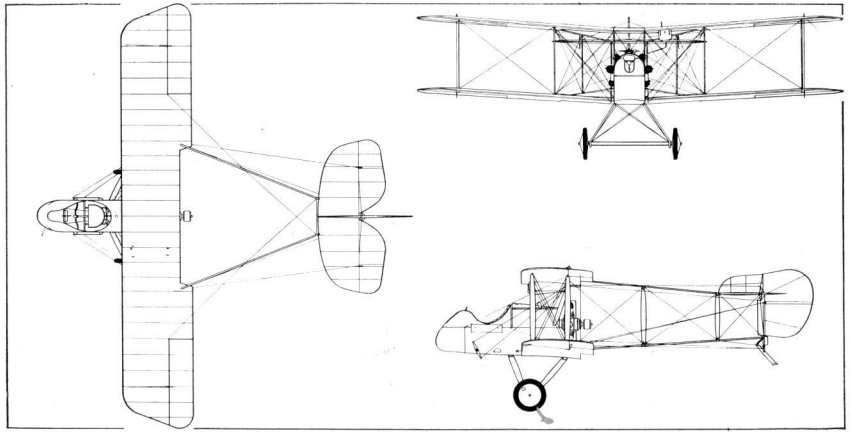
rupter gear he adopted the pusher layout for the Airco D.H.1, which was designed in the autumn of 1914 as a reconnaissance aircraft. Similarly, the first de Havilland-designed Airco single-seat fighting scout, the D.H.2, was a pusher. It was designed early in 1915.

The D.H.2 was a compact little two-bay biplane of conventional construction, powered by a 100 h.p. Gnôme Monosoupape engine and armed with a single Lewis machine-gun. On the prototype, No. 4732, the gun was carried on a pivoted bracket mounting on the port side of the cockpit. In this aircraft all the petrol was contained in the main tank within the nacelle.

The prototype was sent to France in July 1915, shortly after completing its test flights, and was on the strength of No. 5 Squadron on 31st July, 1915. When the next official Return of Aeroplanes on Charge was rendered on 15th August, No. 4732 was not included. In a statement to the Bailhache Judicial Committee of Inquiry into the administration and command of the R.F.C., the late C. G. Grey said of the prototype D.H.2: "Unfortunately that machine was shot down by the Germans almost the first day it arrived."



Despite this inauspicious start to its career, the D.H.2 was ordered in quantity. The first production machines were delivered towards the end of 1915 and were allocated to No. 24 Squadron R.F.C., which was then working up before proceeding to France. On these aircraft the Lewis gun was installed as a completely free weapon. It was on a central pivoting mounting and could be elevated and depressed. The nose of the nacelle was

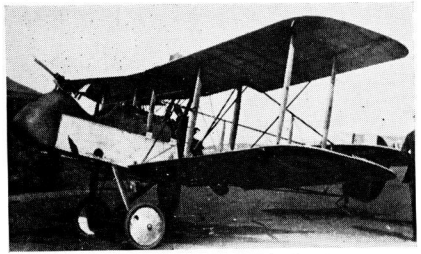


modified, and the pilot's windscreen was attached to the gun. Ammunition drums were carried in external racks on each side of the cockpit. A revised fuel system was fitted; it incorporated a gravity tank, which was carried either under or on top of the port upper mainplane. The Gnôme Monosoupape remained the standard engine, but at least one D.H.2 was fitted with the 110 h.p. Le Rhône. This aircraft was tested at C.F.S., but in performance was inferior to the standard aircraft: its speed at 5,000 ft. was 85 m.p.h. and it took 31 min. to climb to 10,000 ft. One aircraft (No. 8725) was ordered by the Admiralty, but the type was not adopted for the R.N.A.S., and this D.H.2 was transferred to the R.F.C.

In service the D.H.2 was not at first popular. Its small speed range and sensitive controls demanded careful handling, consequently spinning accidents occurred, many with fatal results. Once its handling characteristics were understood, however, the D.H.2 came to be recognised as a sturdy and manoeuvrable fighting scout.

When No. 24 Squadron went to France on 7th February, 1916, equipped throughout with D.H.2s, it became the first single-seat fighter squadron to go to war. It was commanded by Major L. G. Hawker, V.C. The D.H.2 was also flown by R.F.C. Squadrons Nos. 29 and 32, which went to France on 25th March and 28th May, 1916, respectively. Of the total of 400 production D.H.2s, 266 were sent to France.

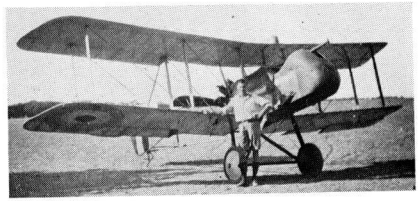
Although the D.H.2 was not fast, its strength and manoeuvrability made it a formidable



D.H.2 with free-mounted Lewis gun.

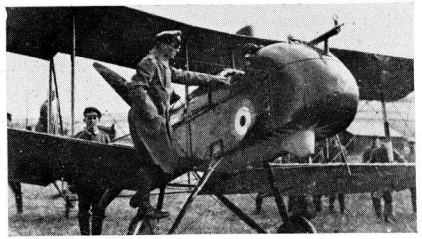
fighter in its day, and it played a large part in defeating the Fokker monoplane. It was found that the Lewis gun's flexibility was a disadvantage rather than an asset; the gun was ultimately fixed to fire forward along the line of flight, and the pilots mastered the technique of aiming their aircraft at the target. In the hands of such pilots as Captain A. M. Williamson, D.S.O., Captain J. O. Andrews, D.S.O., M.C., 2nd Lt. E. C. Pashley, and Captain S. H. Long, D.S.O., M.C., the D.H.2 scored many combat successes. On 1st July, 1916, Major L. W. B. Rees, O.C. No. 32 Squadron, flying the D.H.2 No. 6015, won the V.C. for his combat with ten enemy bombers. In No. 29 Squadron, Sgt. J. T. B. McCudden, whose final victory score was to reach 57, began his career as a fighter pilot flying No. 5985.

With the appearance of the German Albatros and Halberstadt tractor biplanes the D.H.2 was outclassed. This seemed to be symbolized in the death of Major L. G. Hawker when, flying No. 5964, he was shot down and killed by Manfred von Richthofen in an Albatros D.II, on 23rd November, 1916. Yet it was not finally withdrawn until June 1917, when Nos. 24 and 32 Squadrons completed their re-equipment with D.H.5s. A few D.H.2s remained operational in Palestine and Macedonia until the late autumn of that year, and one is reported to have been sent to France in 1918.

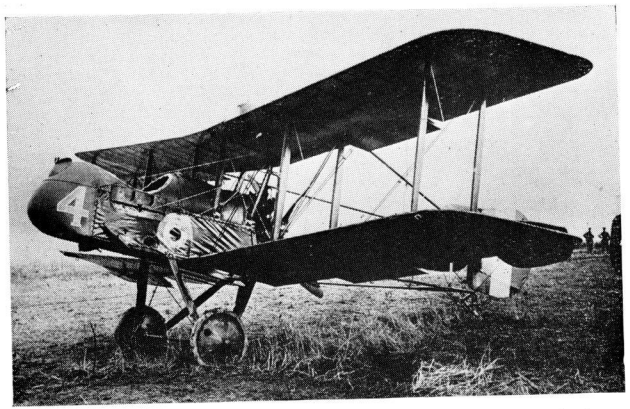


A D.H.2 in Palestine.

Its operational day was by then long past. Some lingered on at training units, to which a total of 100 D.H.2s were sent; and at the Royal Aircraft Factory A2569 was still flying in March 1918, when it was experimentally fitted with Tampier controls.



Oswald Boelcke inspects a captured D.H.2. The Lewis gun is installed as a fixed weapon.



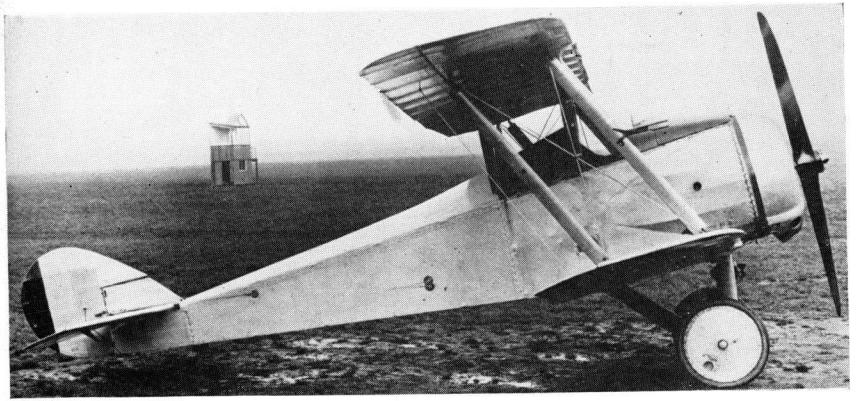
D.H.2 in German hands. Note rack for ammunition drums outside cockpit.

Type: *Single-seat Fighter.* **Power:** *One* 100 *h.p. Gnôme Monosoupape,* 110 *h.p. Le Rhône* 9*J nine-cylinder rotary engines.* **Armament:** *One* 0.303-*in. Lewis machine-gun in front of cockpit.* **Performance:** *Maximum speed,* 93 *m.p.h. at ground level,* 90 *m.p.h. at* 5,000 *ft.,* 77 *m.p.h at* 10,000 *ft. Climb to* 5,000 *ft.,* 8 *min.* 25 *sec.; to* 10,000 *ft.,* 24 *min.* 45 *sec. Service ceiling,* 14,000 *ft. Endurance,* 2¾ *hours.* **Weights:** *Empty,* 943 *lb.; loaded,* 1,441 *lb.* **Dimensions:** *Span,* 28 *ft.* 3 *in.; length,* 25 *ft.* 2½ *in.; height,* 9 *ft.* 6½ *in.; wing area,* 249 *sq. ft.*

DE HAVILLAND D.H.5

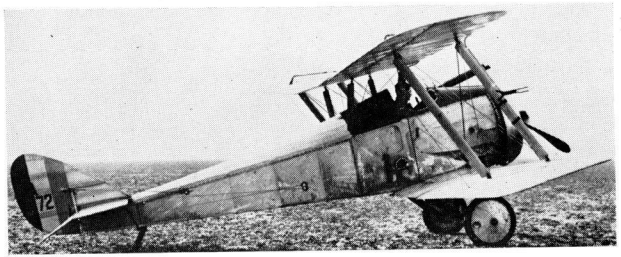
In the D.H.5 Geoffrey de Havilland attempted to combine the superior performance of the tractor biplane with the uninterrupted forward and upward view enjoyed by the pilot of a pusher aircraft. By placing the pilot of the D.H.5 in front of the upper wing he had no choice but to adopt pronounced negative stagger of the mainplanes.

The prototype A5172 was completed late in 1916. It was a single-bay biplane with a wooden airframe, wire-braced and fabric-covered, and was powered by a 110 h.p. Le Rhône rotary engine. Its structure was mostly conventional, but the fuselage was made in two parts, the forward portion incorporating fretted plywood webs that eliminated the need for wire cross-bracing. The fuselage had a rounded top decking and its sides were flat abaft the cockpit. The vertical tail surfaces were small, the rudder being horn-balanced. No armament was fitted. Apart from their backward stagger the mainplanes were conventional. The ailerons were unusually large.



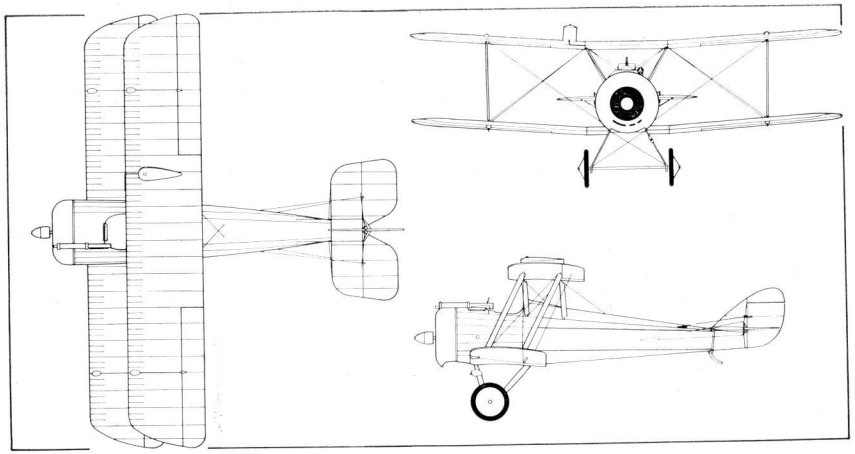
Above, prototype D.H.5 with original fin and rudder, at Hendon.

Right, prototype D.H.5 with enlarged rudder and Vickers gun partly elevated.

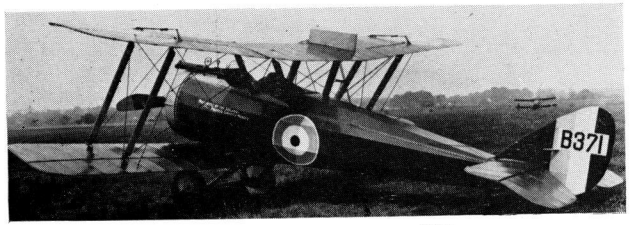


After being test flown by B. C. Hucks at Hendon the prototype underwent official trials in December 1916 and went to France before the end of that year. By this time a single Vickers gun had been fitted; its mounting was designed to enable the gun to be elevated through an upwards arc of about 60°. An enlarged rudder, still horn-balanced, replaced the original; and it is possible that the tailplane and elevator area was also increased. A strut braced the front spar of the tailplane to the lower longeron on each side.

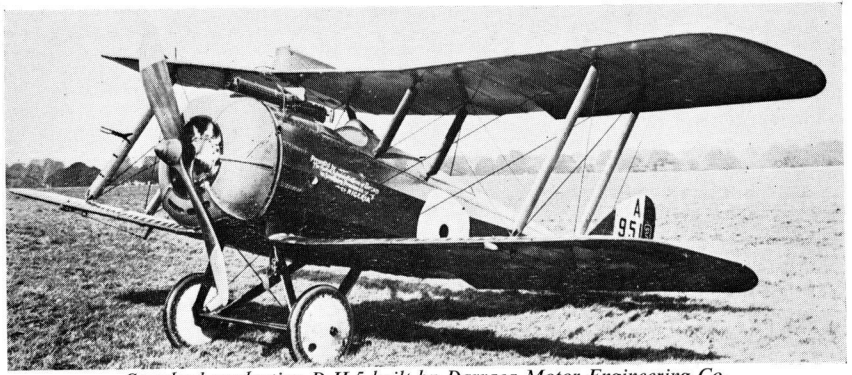
The prototype was manoeuvrable and Central Flying School gave it a good report,



describing it as "handy and quick in the air", and "easy to land and fly". Although the D.H.5's performance proved to be no better than that of the earlier Sopwith Pup it was put into production, a total of 549 being ordered from the Aircraft Manufacturing Co. Ltd., the Darracq Motor Engineering Co. Ltd., the British Caudron Co. Ltd., and March, Jones and Cribb Ltd. The production D.H.5 differed from the prototype in having the fuselage faired to an octagonal cross-section throughout its length behind the



Production D.H.5 built by British Caudron.



Standard production D.H.5 built by Darracq Motor Engineering Co.

cockpit. A plain rudder without horn balance was fitted and the gun was fixed to fire parallel to the line of flight. The fuel system was improved by fitting a five-gallon gravity tank above the upper wing.

Five R.F.C. Squadrons used the D.H.5, namely Nos. 24, 32, 41, 64 and 68 (No. 2 Squadron, Australian Flying Corps). The first to reach No. 24 Squadron at Flez was delivered on 1st May, 1917, but the type was not so well-liked as its pusher predecessor. The historian of No. 24 Squadron recorded: "Unfortunately the new machine was a failure, and . . . despite every effort on the part of the pilots success in any way comparable with their early efforts and results was postponed until late in the year."

The unconventional appearance of the D.H.5 prejudiced pilots against it and inspired a number of rumours to the effect that it was dangerous to fly. These were largely baseless, but as a combat aircraft it suffered from the defect that its performance above 10,000 ft. was poor.

By the time No. 68 Squadron reached France on 21st September, 1917, the D.H.5 had found its métier. Its immense structural strength and good forward view made it an ideal ground-attack aircraft. The last D.H.5 squadron to take the field was No. 64, whose training had included much low-level flying. This unit arrived in France on 14th October, 1917, in time for the Battle of Cambrai, in which its D.H.5s and those of No. 68 Squadron did much hazardous work at considerable cost in men and machines. On their ground-attack missions the D.H.5s carried four 25-lb. bombs.

The withdrawal of the D.H.5 had begun before the Battle of Cambrai, No. 41 Squadron having received S.E.5a's in October 1917. By the end of January 1918 the D.H.5 had disappeared from the Western Front. Its unpopularity ensured that it did not survive long at training units.

Few experiments were made with the type. One machine had a 110 h.p. Clerget in place of the standard Le Rhône and at least one installation of a 100 h.p. Gnôme Monosoupape was made, probably at a training unit. On A9186 the Vickers gun was mounted at an upward angle of 45°, possibly with anti-airship duties in view. On 12th July, 1917, A9403 was sent to the Royal Aircraft Factory for tests of its plywood-covered fuselage and the experimental Lott detachable petrol tank. Engine trouble and excessive vibration made the results of these experiments worthless.

The D.H.5 disappeared rapidly and by 31st October, 1918, none remained on charge with the Royal Air Force.

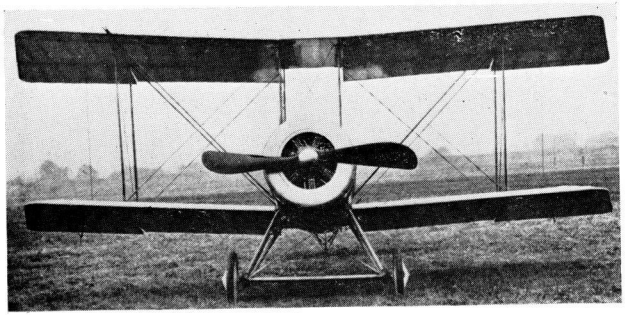
Type: *Single-seat Fighter.* **Power:** *One* 110 *h.p. Le Rhône 9J,* 110 *h.p. Clerget 9Z,* 100 *h.p. Gnôme Monosoupape, all nine-cylinder rotary engines.* **Armament:** *One fixed* 0.303-*in. Vickers machine-gun with Constantinesco C.C. synchronizing gear.* **Performance:** *Maximum speed,* 102 *m.p.h. at* 10,000 *ft.,* 89 *m.p.h. at* 15,000 *ft. Climb to* 10,000 *ft.,* 12 *min.* 25 *sec.; to* 15,000 *ft.,* 27 *min.* 30 *sec. Service ceiling,* 16,000 *ft. Endurance,* 2¾ *hours.* **Weights:** *Empty,* 1,010 *lb.; loaded,* 1,492 *lb.* **Dimensions:** *Span,* 25 *ft.* 8 *in.; length,* 22 *ft.; height,* 9 *ft.* 1½ *in.; wing area,* 212.1 *sq. ft.*

GRAHAME-WHITE TYPE 20

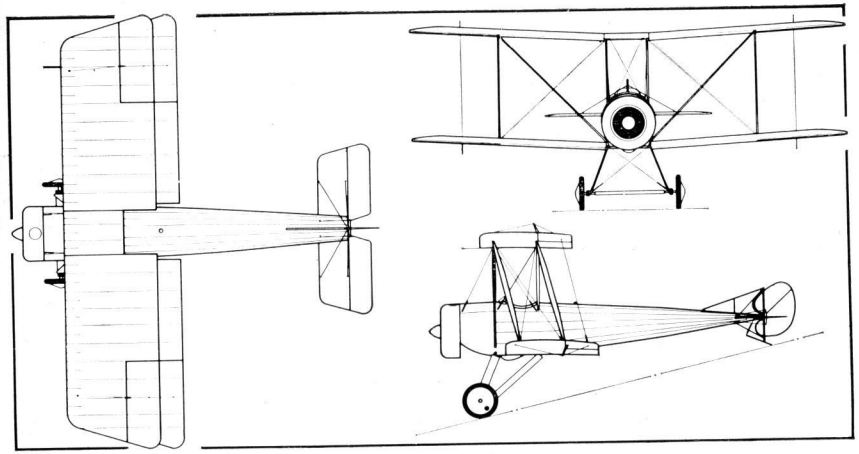
Before the war the Grahame-White Aviation Co. Ltd. had acquired the British licence for the manufacture of the Morane-Saulnier monoplane, several examples of which were built in 1914 and 1915 for the Royal Flying Corps.

After the outbreak of war the company became contractors for the B.E.2c, but maintained a design office and built a series of prototypes of their own design. In 1916 the Grahame-White Type 20 appeared.

This was a small single-seat biplane powered by an 80 h.p. Clerget rotary engine. The basic structure of its fuselage was virtually that of a Morane-Saulnier Type G or Type H, but formers and stringers were added, fairing it out to a circular cross-section throughout its length. A conventional tailplane and elevator

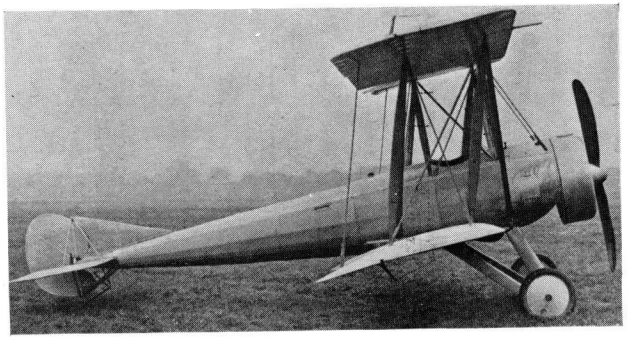


Grahame-White Type 20.



were fitted, and there was a fixed fin; the balanced rudder was somewhat similar to that of the Grahame-White monoplane of 1912.

The Grahame-White Type 20 had single-bay wings of unusually thick aerofoil section. The great gap, which may have been chosen



Grahame-White Type 20.

because the pilot sat under the centre section, gave the aircraft an ungainly appearance. Ailerons were fitted to upper and lower mainplanes, and the duplicated flying wires were faired together to reduce drag.

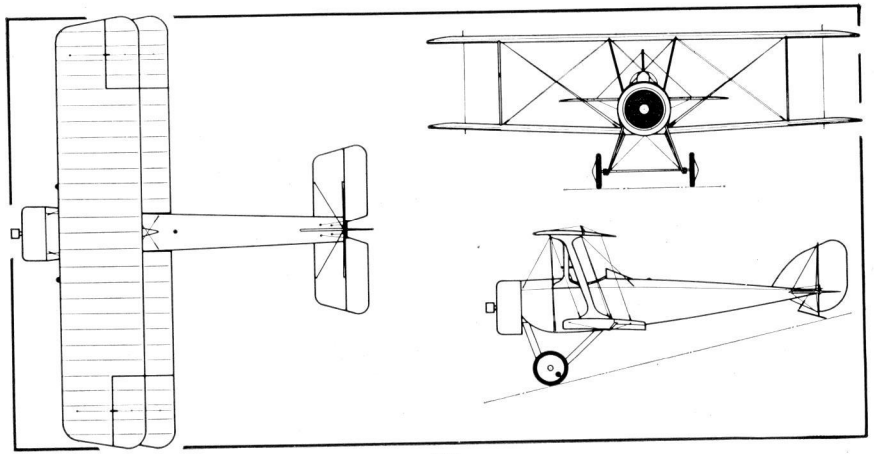
As an alternative power unit the Type 20 could have the 80 h.p. Le Rhône, and there is an indication that a 100 h.p. engine could be installed. A speed of "approximately 100 miles an hour" with an 80 h.p. engine was claimed, but the aircraft never underwent official trials and no authenticated performance figures are available.

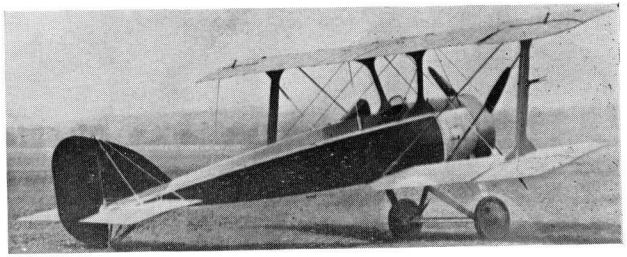
Type: *Single-seat Scout.* **Power:** *One* 80 *h.p. Clerget seven-cylinder rotary engine,* 80 *h.p. Le Rhône* 9C *nine-cylinder rotary engine.* **Armament:** *None.* **Performance:** *Maximum speed, approximately* 100 *m.p.h. at ground level.* **Weights:** *No details available.* **Dimensions:** *No details available.*

GRAHAME-WHITE TYPE 21

The Grahame-White Type 21 appeared in April 1917 and was a more serious attempt to produce a single-seat scout. It was rather better proportioned than the Type 20, and considerable care had been taken to keep drag to a minimum.

As on the Type 20, the basic box-girder of the fuselage appeared to be that of a Morane-





Grahame-White Type 21.

Saulnier monoplane, but was not fully faired. A rounded top-decking was fitted, and there was a head-rest behind the cockpit. A more conventional tail unit incorporated a fixed tailplane; the high-aspect-ratio rudder was not balanced and the vertical tail assembly had pleasing lines.

Only the lower wings had dihedral, but again ailerons were fitted to upper and lower wings. The most remarkable feature of the aircraft was its single I-type interplane and centre-section struts, which were basically similar to those of the S.E.4. As on the Type 20, the duplicated flying wires were faired together.

The cockpit was under the centre section, which was covered with transparent material to improve the pilot's upward view. The undercarriage was of wide track, and the V-struts were broader than those of the Type 20.

Power was provided by an 80 h.p. Le Rhône engine, and the aircraft was tested with four-blade and two-blade airscrews. A speed of 107 m.p.h. was claimed, but this was not good enough for mid-1917 and the Type 21 was not developed.

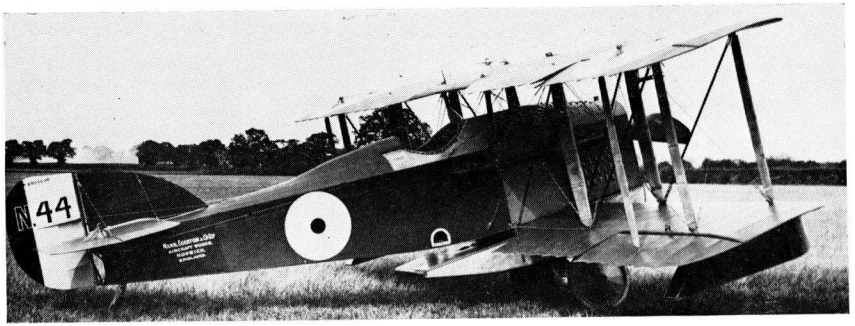
Type: *Single-seat Scout.* **Power:** *One* 80 *h.p. Le Rhône* 9C *nine-cylinder rotary engine.* **Armament:** *No details available.* **Performance:** *Maximum speed,* 107 *m.p.h. at ground level.* **Weights:** *No details available.* **Dimensions:** *No details available.*

MANN, EGERTON TYPE H

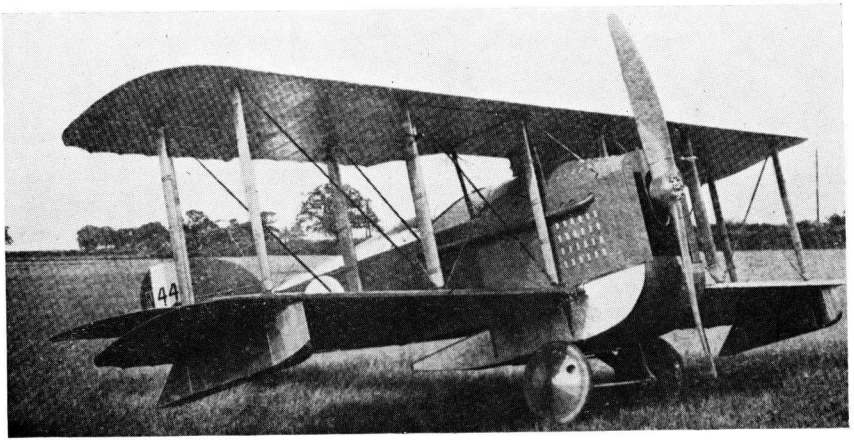
The name of Mann, Egerton and Co., Ltd., is still well-known to automobile cognoscenti. In the spring of 1915 the firm became contractors for the Short 184 seaplane, and subsequently manufactured the Short Bomber, Sopwith 1½-Strutter and Spad S.7 for the Admiralty. The company designated each aircraft type by an identifying letter.

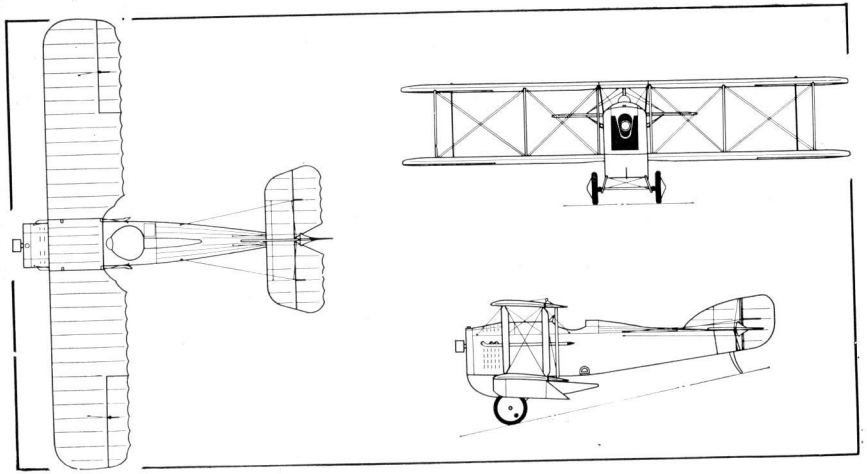
Their Type F would have been an aeroplane of their own design, but was abandoned owing to the Admiralty's pressing desire to have Spad production initiated without delay. The Spad was Mann Egerton Type G.

In 1917 the Mann Egerton Type H was designed by J. W. Carr, an American who before the war had worked for the Deperdussin



Mann Egerton H.1.



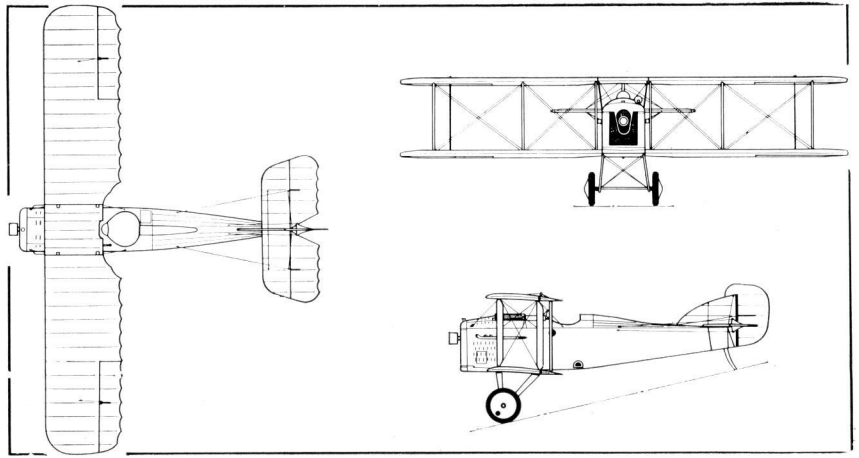


company in Paris, subsequently becoming Koolhoven's assistant with the British Deperdussin firm. He had also designed the Perry Beadle biplane of 1914.

The Type H was a single-seat fighter designed for shipboard use; it met the terms of the official specification N.1a, and serial numbers (N44–N49) were allotted for six prototypes. Only two were completed and flown, however.

Both were basically similar, being two-bay, equal-span biplanes powered by the 200 h.p. Hispano-Suiza engine. The wings could be folded, and had neither stagger nor dihedral. Construction was conventional throughout, and the workmanship and finish were excellent. The equipment, in conformity with specification N.1a, consisted of a fixed Vickers gun with 250 rounds, a Lewis gun with three drums of ammunition, and a removable wireless set, Type 52a. Slinging gear was fitted above the centre section.

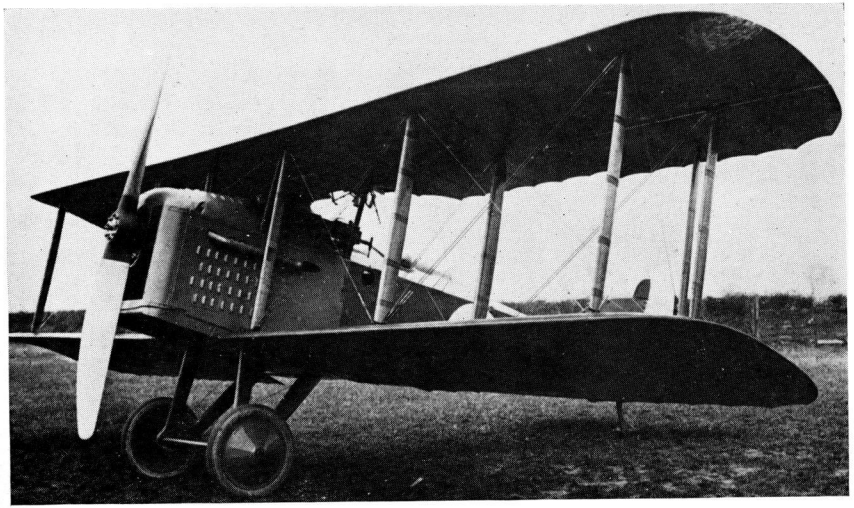
The first aircraft, N44, had a large flat-bottomed float of rather uninspired design attached to the undersurface of the fuselage; in addition there were buoyancy chambers in the rear of the fuselage. The undercarriage, which had very short V-struts attached to the underside of the external float, was jettisonable in order to minimize the risk of overturning on striking the water, and there were wing-tip floats to stabilize the aircraft once it was on the water. The cowling of the frontal radiator was completely flat.



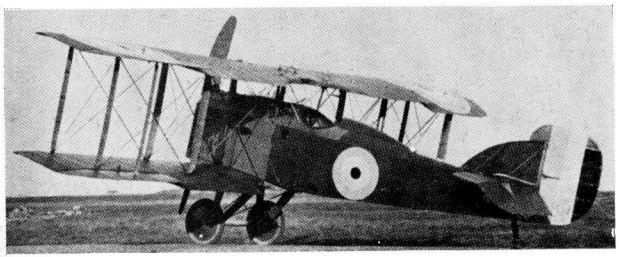
Initial test flights were made by Clifford Prodger and the official test report on N44 is dated October 1917. Rather unexpectedly, the level-speed performance figures for N44 without undercarriage were no better than those obtained with wheels in place, but the rate of climb was improved. In the air the machine handled well and was easy to land; it was regarded as suitable for night flying. The aircraft failed to meet the requirements of the flotation test, however, and could not be accepted.

The second machine, N45, was known as the Mann Egerton H.2, N44 having been H.1. The H.2 had no external fixed floats but was fitted with inflatable air bags; its undercarriage V-struts were of conventional size and shape but the entire unit was still jettisonable. A larger, horn-balanced rudder was fitted to N45, the cowling of its radiator was rounded off, and the exhaust pipes were shorter than those of N44.

Officially tested in December 1917, N45 had a better performance than N44. It was not adopted for Service use, however. The reasons for its rejection are not known, but it seems likely that its performance was not good enough for anti-Zeppelin work. Moreover, by the time the H.2 was tested, the Sopwith 2F.1 was beginning to prove adequate for shipboard fighting duties, and the Sopwith was a simpler aircraft.



Mann Egerton H.2.



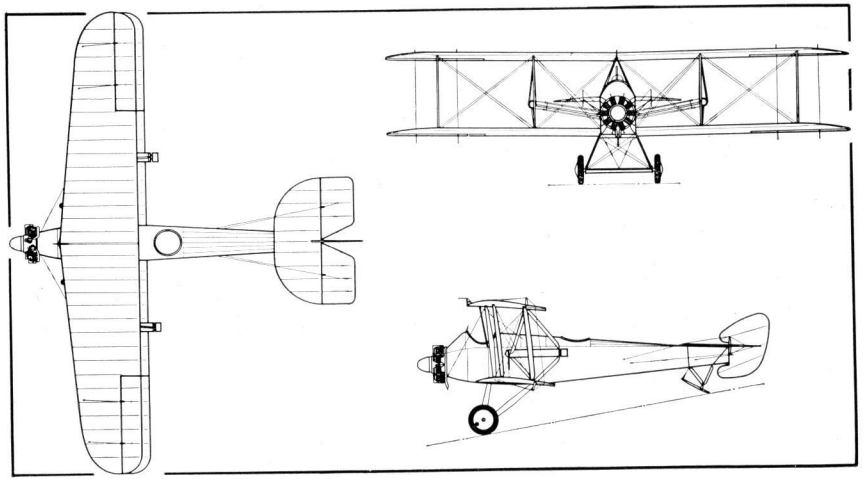
Mann Egerton H.2 at the Isle of Grain.

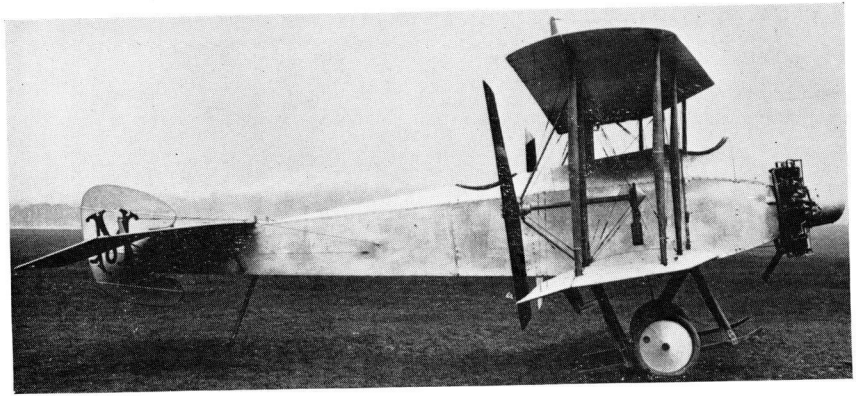
Type: *Single-seat Shipboard Fighter.* **Power:** *One* 200 *h.p. Hispano-Suiza* 8*Bd eight-cylinder water-cooled engine.* **Armament:** *One fixed* 0.303-*in. Vickers machine-gun on top of fuselage, mounted to port; one* 0.303-*in. Lewis machine-gun above centre section.* **Performance:** (*H.*1), *Maximum speed,* 100 *m.p.h. at* 6,500 *ft.,* 90 *m.p.h. at* 10,000 *ft. Climb to* 6,500 *ft.,* 9 *min.* 10 *sec., to* 10,000 *ft.,* 18 *min. Service ceiling,* 12,800 *ft.* (*H.*2), *Maximum speed,* 113 *m.p.h. at* 6,500 *ft.,* 110 *m.p.h. at* 10,000 *ft. Climb to* 6,500 *ft.,* 6 *min.* 25 *sec., to* 10,000 *ft.,* 12 *min.* 30 *sec. Service ceiling,* 16,800 *ft. Endurance,* 3¼ *hours.* **Weights:** (*H.*1), *Empty,* 1,831 *lb.; loaded,* 2,404 *lb.* (*H.*2), *Empty,* 1,760 *lb.; loaded,* 2,326 *lb.* **Dimensions:** *Span,* 30 *ft.* 9 *in.; length,* 21 *ft.* 11 *in.; height,* 8 *ft.* 11½ *in.; wing area,* 310 *sq. ft.*

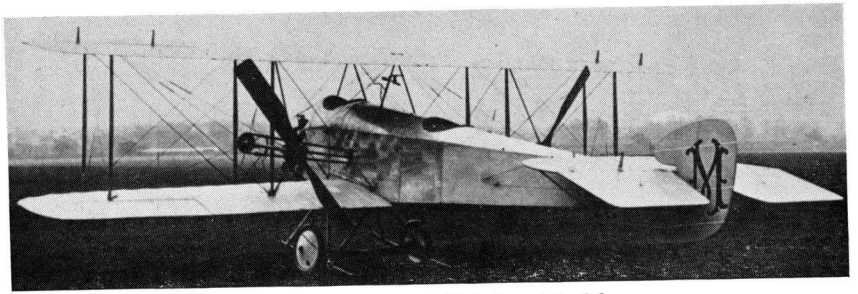
MANN & GRIMMER M.1

During the evolution of fighting aeroplanes there have emerged from time to time aircraft that were dead-end designs and only marginally suitable for their intended function. One such was the Mann & Grimmer M.1 of 1915.

The design of the M.1 was begun by R. F.





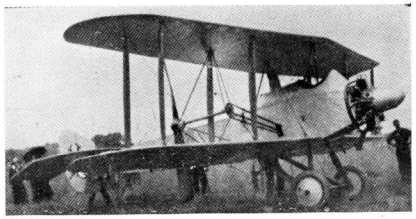


The Mann & Grimmer M.1 in its original form.

Mann in August 1914. He was then 17, having worked with his former schoolmaster, R. P. Grimmer, in designing and marketing model aeroplanes in the pre-war years. Mann had recognised, some time before the war began, that gun-carrying aeroplanes would be needed in any major conflict. He gave his ideas expression in the design of the M.1.

With financial backing provided by Mr. W. H. Bonham-Carter, work on the construction of a prototype began in September 1914. By dint of working long hours, the major components were completed at Surbiton at the end of January 1915, when they were taken to Hendon. The M.1 was assembled there in the following month.

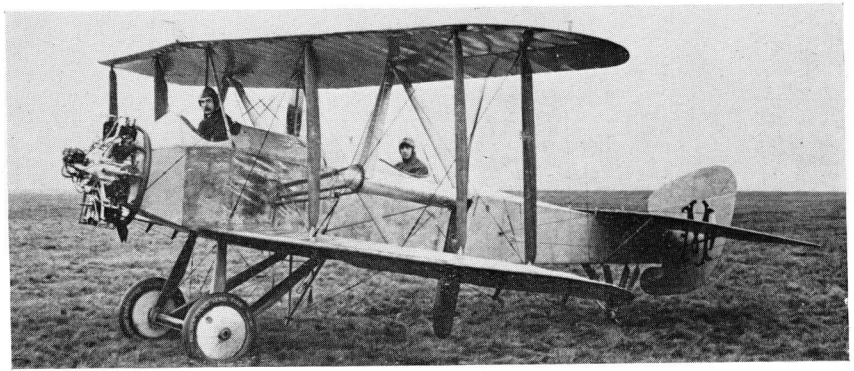
It was an ugly, ill-proportioned two-bay biplane characterized by an extraordinary power installation. In the M.1, Mann tried to combine the tractor layout, which promised better performance, with pusher airscrews, which offered the gunner a clear field of fire in forward directions. The M.1 had two pusher airscrews carried on an inadequate-looking system of struts about the inner rear interplane strut on each side. The 100 h.p. Anzani radial engine was mounted in the conventional place at the front of the fuselage



The M.1 at a late stage of its development.

but it was installed back to front, with a central bullet-like fairing over what was normally the back of the crankcase; an extended shaft drove the airscrews via a gear-box and chains.

Close behind the engine was the gunner's



Final form of the M.1 with rear inner interplane struts removed and fairings on airscrew shafts and supporting struts.

cockpit. Its position was poor, and it would have been difficult to mount and use a Lewis gun effectively from it. The pilot sat well aft, too far from the gunner for any crew co-operation to be possible in combat.

The basic structure of the M.1 was conventional. In its original form it had two short skids on the undercarriage and its long tail-skid was pivoted and sprung internally. In this form it made its first flight on 19th February, 1915, in the hands of W. Rowland Ding.

Early flights showed that the rudder was ineffective, having no slipstream passing over it, and that the chain transmission was not satisfactory. A bigger rudder and new airscrews were fitted, but the aircraft's performance was poor.

A 125 h.p. Anzani replaced the original, new transmission was installed, a V-type undercarriage and an even larger rudder were fitted. After several incidents and vicissitudes the Mann & Grimmer M.1 was attaining speeds of 75 to 80 m.p.h. by August 1915. Refinements were made, notably to the airscrew-supporting structures, and the speed went up to 85 m.p.h. The various modifications had increased the empty weight from 1,300 lb. to roughly 2,100 lb., an increase of over 60 per cent.

The aircraft was offered for sale in November 1915, but was wrecked on the 16th of that month with a total of about 18 flying hours to its credit. It was said in the House of Commons that the M.1 would have been tested by the R.F.C had it not been destroyed. It could only have been rejected, for it would have been useless in combat and too complicated for service in the field. Mr. Bonham-Carter felt unable to continue to finance the construction of another aircraft and withdrew his support in March 1916.

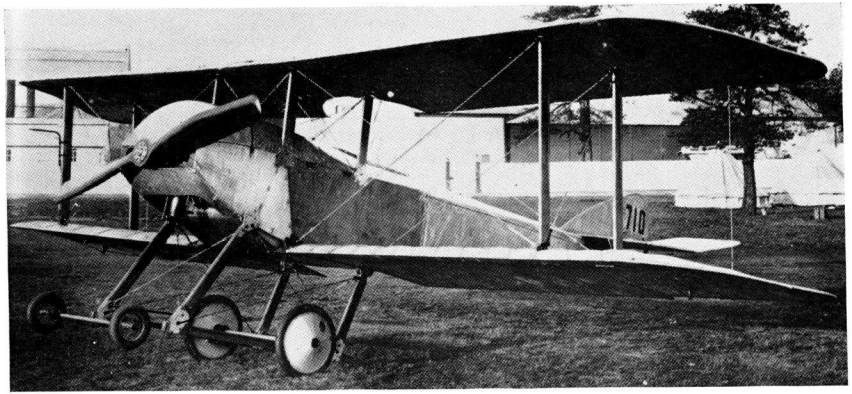
An improved design, variously referred to as the M.2, M.2A and M.2B, was submitted to the War Office; a designed speed of 100 m.p.h. was hoped for. According to R. F. Mann and R. P. Grimmer an official contract was awarded for a prototype and construction was started. They alleged that they gave the contract and payment to Mr. Bonham-Carter and had an understanding with him relating to the construction of the M.2. According to them, the company was subsequently broken up by Bonham-Carter's action, and the incomplete M.2 was sold to Blériot Aeronautics of Brooklands.

Type: *Two-seat Fighter-reconnaissance.* **Power:** *One* 100 *h.p. Anzani*, 125 *h.p. Anzani ten-cylinder air-cooled radial engine.* **Armament:** *One free* 0.303-*in. Lewis machine-gun.* **Performance:** *Maximum speed*, 85 *m.p.h. Climb to* 3,000 *ft.*, 8 *min. Endurance*, 4½ *hours.* **Weights:** *Empty, about* 2,100 *lb.*; *loaded, about* 2,800 *lb.* **Dimensions:** *Span*, 34 *ft.* 9 *in.*; *length*, 26 *ft.* 5 *in.*; *wing area*, 322 *sq. ft.*

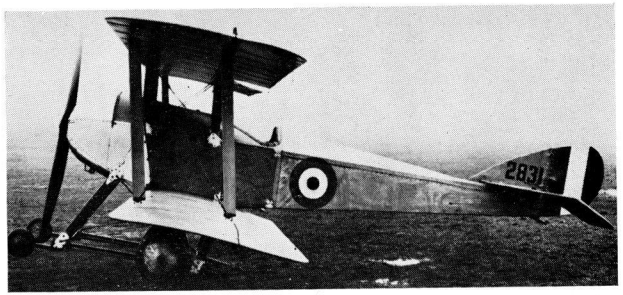
MARTINSYDE S.1

In the weeks preceding the outbreak of war it became known that the Martinsyde company were building a single-seat biplane "of the small fast scouting type". Doubtless the firm had been inspired by the success of the Sopwith Tabloid and Bristol Scout.

The first Martinsyde Scout was delivered to the Royal Aircraft Factory at Farnborough for the use of the R.F.C. in October 1914. It was a clean little single-bay biplane powered by an 80 h.p. Gnôme rotary engine, its appearance spoiled only by the sturdy but clumsy

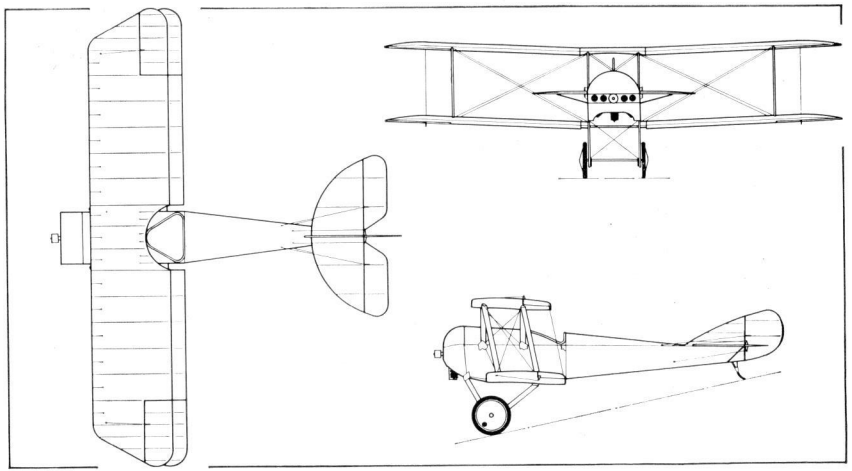


Above, The first Martinsyde S.1 No. 710 at Farnborough 28th October 1914.



Right, A later Martinsyde S.1 with modified cockpit opening.

four-wheel undercarriage. The design of the engine installation was similar to that of the Sopwith Tabloid, but the tail unit was characteristically Martinsyde. In construction the Martinsyde Scout was typical of its period, but incorporated some design details that became characteristic of later Martinsyde aircraft designed by A. A. Fletcher. The wooden airframe was wire-braced and fabric-covered; the fuselage was covered with ply-



wood between the cockpit and the engine cowling.

Several small batches of Gnôme-powered Martinsydes, totalling over sixty aircraft, were ordered; the type was designated Martinsyde S.1. Deliveries were made throughout 1915 until October, when production ceased. The earliest production S.1s resembled the prototype; later aircraft had the cockpit cut lower at the sides; and finally a neat but narrow V-type undercarriage replaced the original four-wheel affair. Some late S.1s also had a revised tailplane with a straight leading edge.

The Martinsyde S.1 saw little service with the R.F.C. Only six went to France, where squadrons Nos. 1, 4, 5, 6 and 16 each had one or, at most, two of the type. Although a robust aeroplane, the Martinsyde S.1 was not so pleasant to fly as its Bristol and Sopwith contemporaries. The lateral control provided by its small ailerons was poor and its performance, both in speed and climb, was unspectacular.

Although withdrawn from R.F.C. units in France in the summer of 1915, the Martinsyde S.1 was apparently considered good enough for service in Mesopotamia, whence four were sent in August 1915. The heat and dust reduced their performance further, yet they made some useful flights in the hands of No. 30 Squadron, R.F.C. By November 1915 they were all out of action.

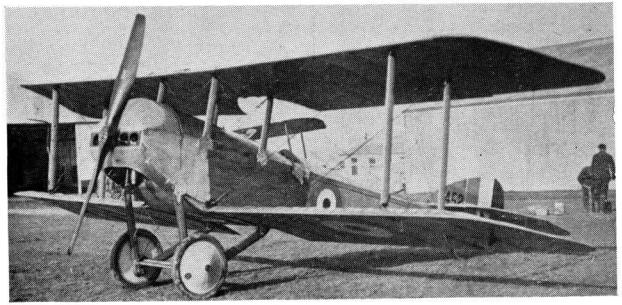
At aerodromes in the United Kingdom the

Martinsyde S.1 was used on a limited scale for training purposes; and some were regarded as anti-airship aircraft, based at such aerodromes as Farnborough, Brooklands, Hounslow, Dover, Joyce Green, Northolt and Shoreham. The chances of any S.1, loaded with its full specified complement of six bombs, twelve Hales grenades, 150 incendiary darts and five powder bombs, being able to bring a Zeppelin to action were negligible, and no such engagement ever occurred.

A few specimens of the type survived until the spring of 1916, but the S.1 then disappeared, to be outlived by its more distinguished predecessor, the Bristol Scout.

Martinsyde S.1 with V-type undercarriage.

Martinsyde S.1 of the final production batch with late-type tailplane with straight leading edge.



Type: *Single-seat Scout.* **Power:** *One* 80 *h.p. Gnôme seven-cylinder rotary engine.* **Armament:** *None standard. The S.1 of No.* 6 *Squadron, R.F.C., had a Lewis machine-gun mounted on the centre section; Home Defence aircraft were expected to carry a variety of anti-airship weapons.* **Performance:** *Maximum speed,* 87 *m.p.h. at ground level.* **Weights:** *No details available.* **Dimensions:** *Span,* 27 *ft.* 8 *in.; length,* 21 *ft.; wing area,* 280 *sq. ft.*

MARTINSYDE G.100 & G.102

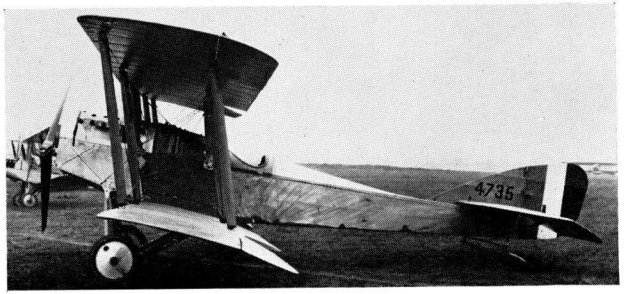
In the summer of 1915 A. A. Fletcher designed the Martinsyde G.100 single-seat scout, a larger and more advanced aircraft than the little S.1. Designed for the 120 h.p. Beardmore engine, the G.100 was unusually large for a single-seater; its two-bay wings spanned 38 ft. The large size was dictated by the requirement that the aircraft should have a long range, possibly in order to act as a fighter escort to reconnaissance machines.

The prototype, No. 4735, emerged as a handsome biplane, conventional in construction and with a typically elegant Martinsyde fin and rudder. This aircraft had a 120 h.p. Austro-Daimler engine (No. 302), which drove a three-blade Lang airscrew; the radiator was installed behind the engine.

Tested at Upavon in September 1915, the prototype G.100 proved to have a speed of 95 m.p.h. at 6,500 ft. and climbed to 10,000 ft. in 19 minutes; its flight endurance was 5½ hours. Late in September No. 4735 was at Farnborough. The type was put into production, first deliveries being made at the beginning of 1916.

The production aircraft had a two-blade airscrew, an exhaust manifold, a much cleaner engine cowling, a wind-driven petrol pump on the front leg of the port undercarriage V-strut, and duplicated flying wires. Otherwise they were identical with No. 4735. A Lewis gun was mounted above the centre section to fire forward above the airscrew. At a later stage a second Lewis was fitted on a bracket behind the cockpit on the port side; it was for rearward defence.

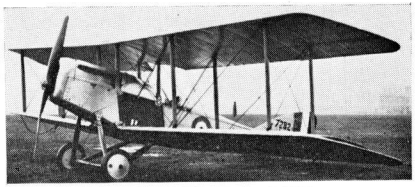
Only one R.F.C. squadron, No. 27, was completely equipped with the new Martinsyde scout. This unit flew the type from the time it went to France on 1st March, 1916, until the Martinsydes were replaced by D.H.4s in November 1917, a remarkable record. Four other squadrons (Nos. 18, 20, 21 and 23) had a few Martinsydes, which they used as escorts for their F.E.2bs, R.E.7s and B.E.2cs. Martinsydes also served in Palestine (R.F.C. Squadrons Nos. 14, 67 and 142) and Mesopotamia (Squadrons Nos. 30, 63 and 72), where they did good work in trying conditions. Of the 270 production aircraft, 133 went to France and sixty-four to the Middle East.



The prototype Martinsyde G.100 at Farnborough, 18th October 1915.

As a fighter the Beardmore-powered Martinsyde was not particularly successful. Its size denied it the agility of smaller contemporary scouts, the pilot's field of view was rather limited, and its armament was not effective enough. It made its mark as a single-seat bomber in all three of the theatres of war in which it operated; it could carry a 230-lb. bomb or an equivalent weight of smaller bombs.

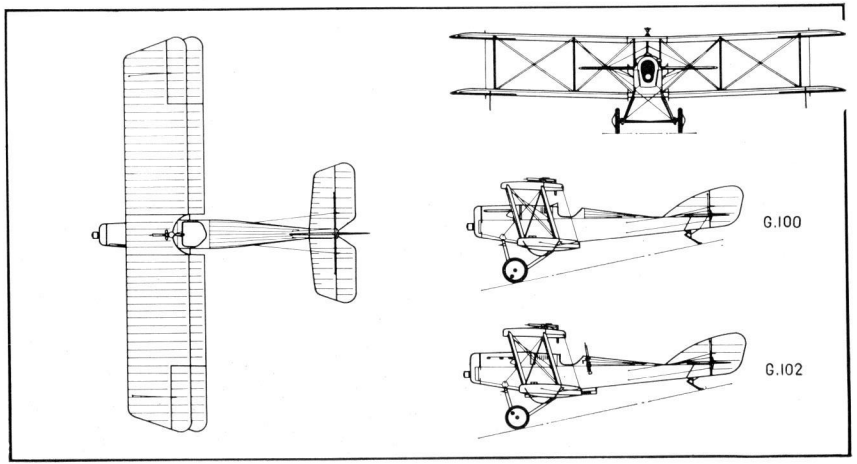
The later aircraft had the 160 h.p. Beardmore engine, which enhanced the performance. The more powerful engine usually had three stub exhausts without a manifold; occasionally, as on A3948, an internal manifold with a single outlet was employed. With the 160 h.p. Beardmore the aircraft was designated



Early production G.100.

Martinsyde G.102, but to the R.F.C. the Beardmore Martinsyde was known as the Elephant. The G.102 replaced the G.100 on all fronts as aircraft became available.

Not all G.102s had the 160 h.p. Beardmore,

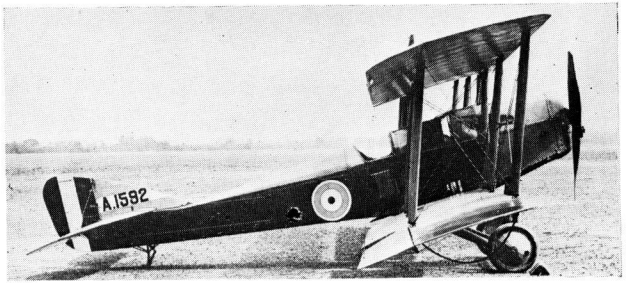


however. It is known that A4001, A6267, A6281 and A6283 all had the 120 h.p. engine, possibly because the more powerful type was scarce or the aircraft were intended for training duties (A6267 later had the 160 h.p. engine, however).

Some surviving documents state that an early experimental installation of a Sunbeam Arab (engine No. 9008) was made in a Martinsyde aircraft in the spring of 1917. The Arab Martinsyde is known to have made its second flight on 18th July 1917. It seems probable that the aircraft must have been a G.100 or G.102.

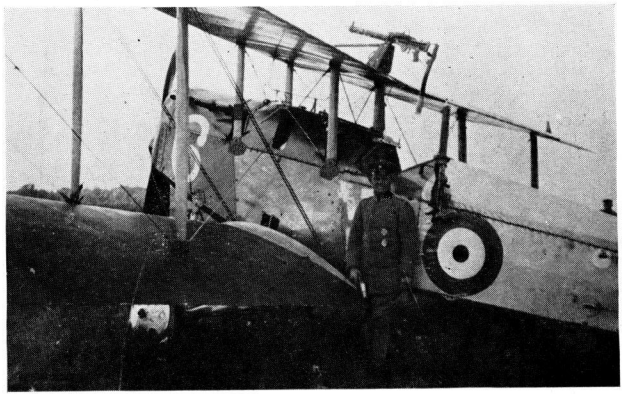
An Eeman triple-gun mounting was tested in a G.102 in August 1917. Three Lewis guns were installed within the fuselage, firing at an upward angle of 45° through slots in the centre section. Presumably this was for Home Defence purposes, but only one Elephant went to a Home Defence squadron.

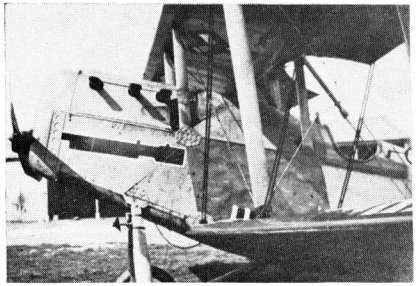
The Martinsyde Elephant was operational with No. 72



Martinsyde G. 102.

Offizier Stellvertreter Max Muller beside a Martinsyde G.102 shot down by him. Both Lewis guns can be seen.

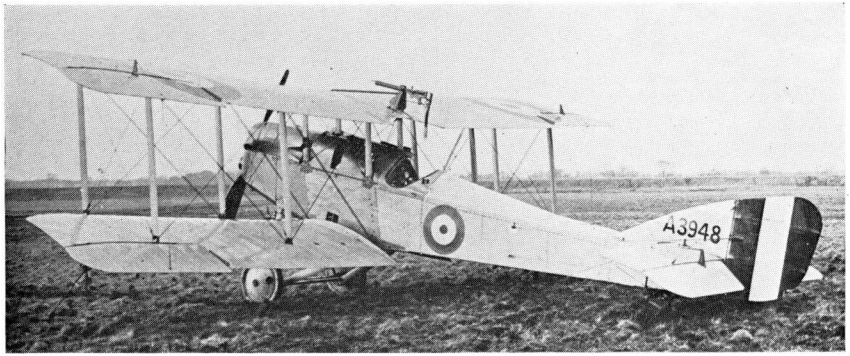




Martinsyde G.102 with Eeman triple gun mounting.

Squadron in Mesopotamia until October 1918. Apparently the type had been everywhere withdrawn by the time that the official statistics of aeroplanes on charge on 31st October 1918 were compiled, but no doubt a few escaped this particular census. One of the last in service, if not on official charge, must have been A6286, a G.102 that was repaired at Farnborough in February 1919, its Rafwire interplane bracing being then replaced by cables; it was flown on the 25th of that month.

Type: *Single-seat Scout.* **Power:** *One* 120 *h.p. Beardmore*, 160 *h.p. Beardmore six-cylinder water-cooled engine.* **Armament:** *Two* 0.303-*in. Lewis machine-guns and bomb load of about* 230 *lb.* **Performance** (*G.*102)**:** *Maximum speed*, 103.1 *m.p.h. at ground level*, 102 *m.p.h. at* 6,500 *ft.*, 99.5 *m.p.h. at* 10,000 *ft. Climb to* 3,000 *ft.*, 3 *min.* 30 *sec., to* 10,000 *ft.*, 15 *min.* 55 *sec. Service ceiling*, 16,000 *ft. Endurance*, 4½ *hours.* **Weights** (*G.*102)**:** *Empty*, 1,793 *lb.*; *loaded*, 2,458 *lb.* **Dimensions:** *Span*, 38 *ft.*; *length*, 26 *ft.* 6½ *in.*; *height*, 9 *ft.* 8 *in.*; *wing area*, 410 *sq. ft.*



Martinsyde G.102 with single-outlet exhaust.

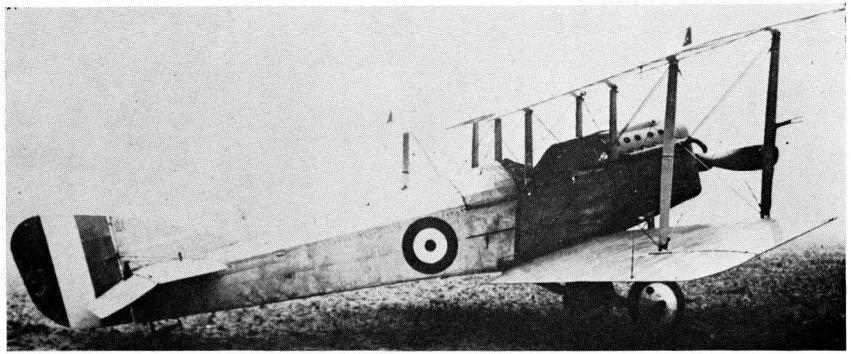
MARTINSYDE R.G.

The Martinsyde R.G. was a late-1916 design for a single-seat fighter powered by the 190 h.p. Rolls-Royce Falcon I engine. It was a single-bay biplane whose descent from the Martinsyde Elephant was obvious, but it was appreciably smaller than its Beardmore-powered predecessor.

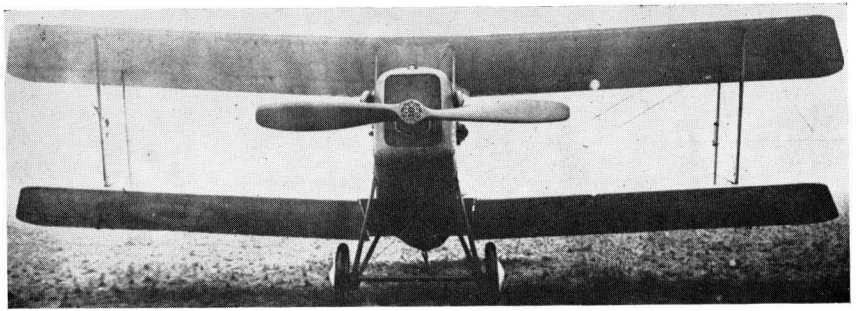
In its structure the R.G. resembled the Elephant closely and bore the design characteristics of A. A. Fletcher. The rear fuselage and tail unit were strongly reminiscent of those of the Elephant, but on the R.G. the incidence of the tailplane could be altered in flight, whereas on the earlier type the tailplane had been fixed. A rectangular frontal radiator was provided for the engine, which drove a two-blade airscrew. The cockpit was under the centre section, consequently the pilot's view was restricted. The mainplanes were of equal span; ailerons were fitted to upper and lower surfaces. The armament consisted of one fixed Vickers gun mounted on the port upper longeron outside the centre-section struts, and a Lewis gun on the starboard side of the cockpit.

The Martinsyde R.G. underwent official trials in February 1917, when it recorded performance figures that were better than those of the S.E.5. The poor position of its pilot was criticized in the official test report, which suggested that the view could be improved by raising the seat and covering the centre section and lower wing roots with transparent material. The Martinsyde company chose to revise the design more thoroughly, however.

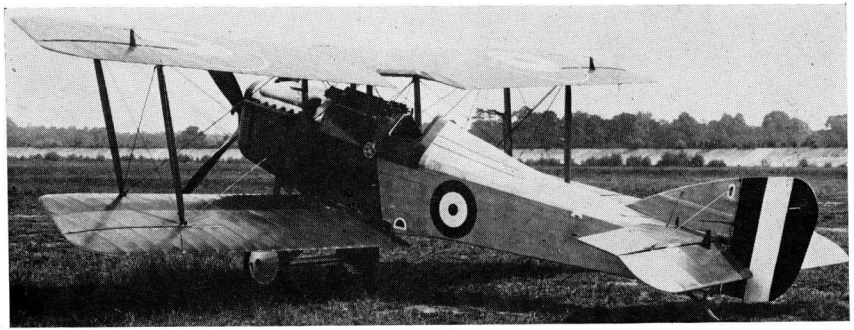
In its modified form the R.G. had its cockpit behind the rear centre-section struts and in line with the trailing edge of the lower wing. The cut-out in the trailing portion of the centre section was considerably enlarged



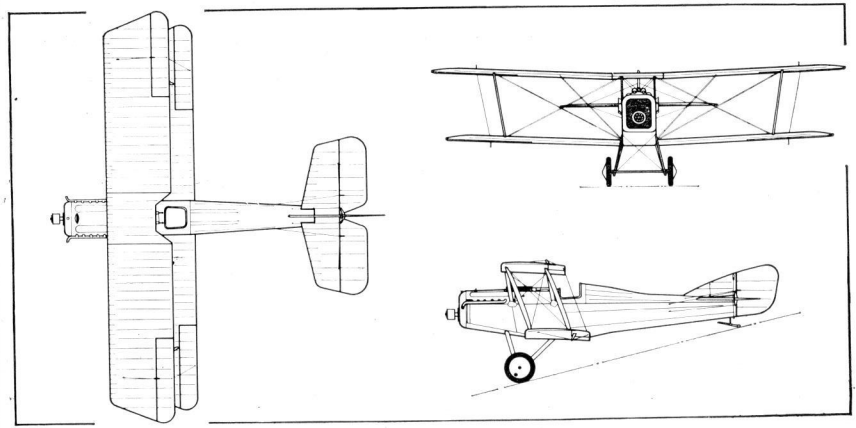
Martinsyde R.G. in its original form.



Martinsyde R.G. in its original form (above) and second form (below).



to increase the pilot's field of view, and the stub wings to which the lower mainplanes were attached were eliminated, thus reducing the lower span by about two feet. The badly disposed armament of the original form of the R.G. was replaced by two Vickers machine-guns mounted externally immediately in front of the cockpit; the rear top decking was heightened to provide a head-rest for the pilot. A four-blade airscrew replaced the original and it is probable that the 275 h.p. Rolls-Royce Falcon III had replaced the



Falcon I, for it is known that an R.G. with a Falcon III was flying in June 1917. These modifications enhanced the aircraft's appearance considerably.

With the Falcon III engine the performance at altitude was greatly improved, and there can be little doubt that the R.G. would have been a considerable weapon if it had gone into production. The reasons why it was not built in quantity have yet to be discovered. Doubtless a major factor was its use of the Rolls-Royce Falcon, the engine that powered the Bristol Fighter and for which the demand already exceeded the supply.

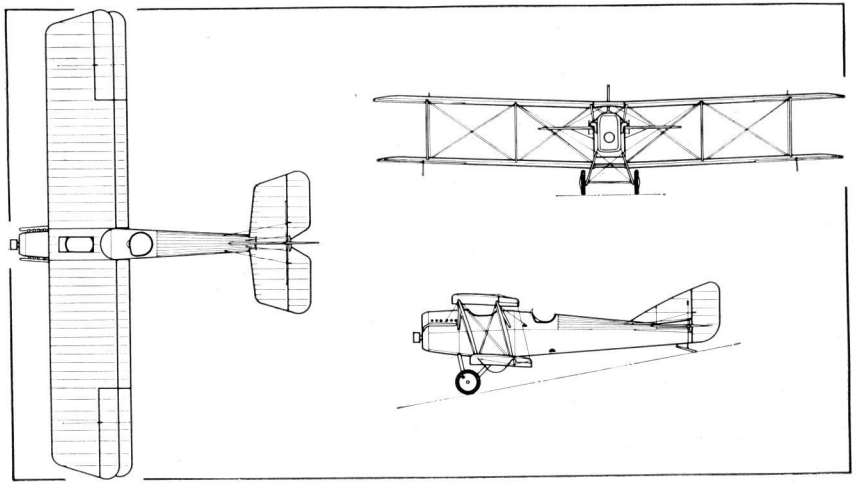
Type: *Single-seat Fighter.* **Power:** *One* 190 *h.p. Rolls-Royce Falcon I,* 275 *h.p. Rolls-Royce Falcon III twelve-cylinder water-cooled engine.* **Armament:** *Originally one fixed, synchronized* 0.303-*in. Vickers machine-gun and one movable* 0.303-*in. Lewis machine-gun; later two fixed, synchronized* 0.303-*in. Vickers machine-guns.* **Performance,** *original form with Falcon I (Falcon III in brackets):* *Maximum speed,* 126.5 *m.p.h.* (132 *m.p.h.*) *at* 6,500 *ft.,* 122 *m.p.h.* (130 *m.p.h.*) *at* 10,000 *ft.,* 115 *m.p.h.* (127.5 *m.p.h.*) *at* 15,000 *ft. Climb to* 10,000 *ft.,* 10 *min.* 20 *sec.* (7 *min.* 20 *sec.*), *to* 15,000 *ft.,* 19 *min.* 20 *sec.* (12 *min.* 50 *sec.*). *Service ceiling,* 22,000 *ft.* (23,500 *ft.*). *Endurance,* 1¾ *hours* (2 *hours*). **Weights,** *original form with Falcon I (Falcon III in brackets):* *Empty,* 1,730 *lb.* (1,740 *lb.*); *loaded,* 2,234 *lb.* (2,261 *lb.*). **Dimensions:** *Span (original form),* 31 *ft.* 10 *in.* (*second form*) *upper* 32 *ft.,* *lower* 30 *ft.*; *length* 25 *ft.* 8 *in.* (*Falcon I*), 25 *ft.* 10 *in.* (*Falcon III*); *height,* 9 *ft.* 10 *in.*; *wing, area,* 310 *sq. ft.*

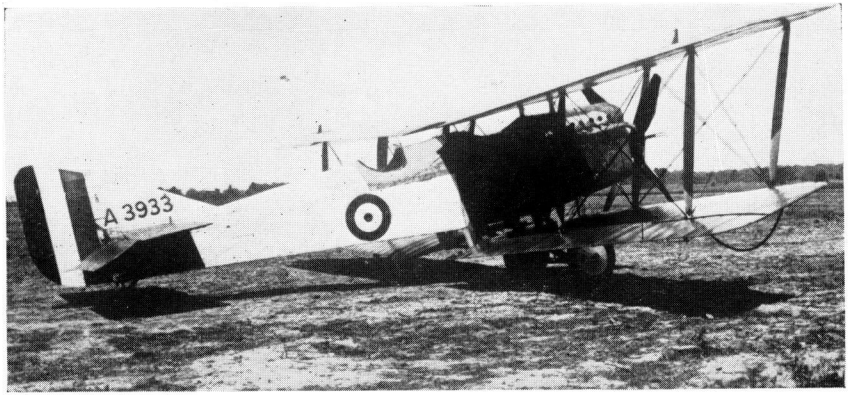
MARTINSYDE F.1

The Martinsyde F.1 was something of an oddity. By mid-1917 it had been conclusively proved that in two-seat tractor aircraft it was essential for the observer to occupy the rear cockpit; and by then the Bristol Fighter was beginning to get into its warlike stride as the exemplar of the ideal crew arrangement. It is therefore remarkable that the observer of the Martinsyde F.1 occupied the forward cockpit, where his combat performance must have been further impaired by the position of the upper wing.

It appears that no armament was ever fitted to the F.1, but there can be no doubt that the observer would have had at least one movable Lewis gun mounted above the centre section, in which there was a large rectangular cut-out immediately above his cockpit.

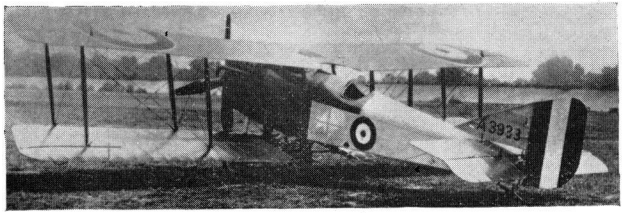
Only one of the two prototypes for which serial numbers (A3933–A3934) were allotted was built. In general appearance it looked like an enlarged Martinsyde Elephant and in construction it was generally similar to the earlier type. The power unit was a 250 h.p. Rolls-Royce Mk III, the engine that was later named Eagle III. It had a frontal radiator and was housed in a deep, bulky cowling. The fuselage was mounted between the wings in mid-gap, possibly to make it easier for the observer to get his head and shoulders to the





Martinsyde F.1 at Martlesham Heath.

Martinsyde F.1.



Martinsyde F.1 at Brooklands.

best level for using his gun. The pilot sat several feet farther aft, well behind the wings.

In spite of the F.1's large size, it was reported to have good flying qualities, stability and controllability, when it was officially tested in July 1917. Its crew arrangement was criticized adversely; and the magneto, carburettors and fuel tanks were said to be very inaccessible.

Obviously the F.1 was not acceptable for operational use. No attempt was made to develop or modify it, but A3933 was not immediately scrapped. It was at Farnborough in July 1918 and was still flying there after the armistice.

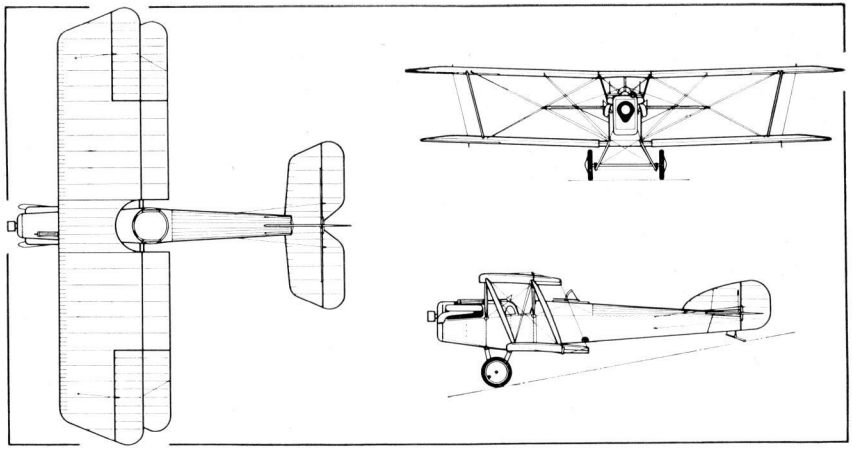
Type: *Two-seat Fighter.* **Power:** *One* 250 *h.p. Rolls-Royce Mk III* (284 *h.p. Eagle III*) *twelve-cylinder water-cooled engine.* **Armament:** *Probably one* 0.303-*in. Lewis machine-gun on upper centre section.* **Performance:** *Maximum speed,* 109.5 *m.p.h. at* 6,500 *ft.,* 104.5 *m.p.h. at* 10,000 *ft.,* 94 *m.p.h. at* 15,000 *ft. Climb to* 10,000 *ft.,* 13 *min.* 40 *sec., to* 16,000 *ft.,* 36 *min.* 20 *sec. Service ceiling,* 16,500 *ft. Endurance,* 3¾ *hours.* **Weights:** *Empty,* 2,198 *lb.; loaded,* 3,260 *lb.* **Dimensions:** *Span, upper* 44 *ft.* 6 *in., lower* 44 *ft.* 2 *in.; length,* 29 *ft.* 1 *in.; height,* 8 *ft.* 6 *in.; wing area,* 467 *sq. ft.*

MARTINSYDE F.2

While the Martinsyde F.1 was being built, a second two-seat fighter, the F.2, was designed and constructed. The F.2 may have been conceived as an alternative to the F.1, to which it bore much the same relationship as the Martinsyde R.G. did to the Elephant. In fact, the F.2 had the same overall dimensions as the R.G., but its wings were of greater chord.

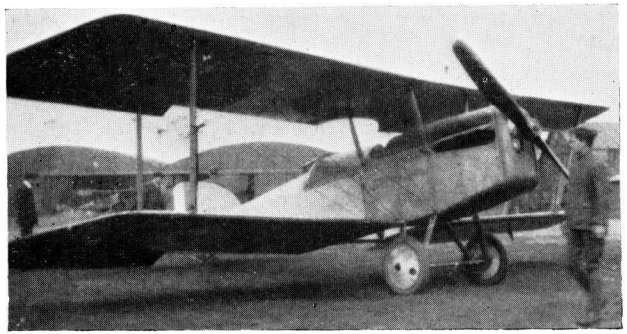
In the F.2 the pilot and observer were accommodated in the classic manner, back to back, with the pilot in the forward cockpit. A single fixed Vickers gun, mounted to port of centre, was provided for the pilot; the observer had a Lewis gun on a Scarff No. 2 Ring Mounting. Unfortunately, as on the original Martinsyde R.G., the pilot of the F.2 sat under the centre section, where he had the worst possible field of view.

The F.2 was a handsome single-bay biplane powered by a 200 h.p. Hispano-Suiza engine. Its airframe was a conventional wire-braced wooden structure; the forward sides and top decking of the fuselage were plywood-covered; all other areas were covered with fabric. The F.2 was the first Martinsyde aircraft to have the characteristic shape of fin and rudder that

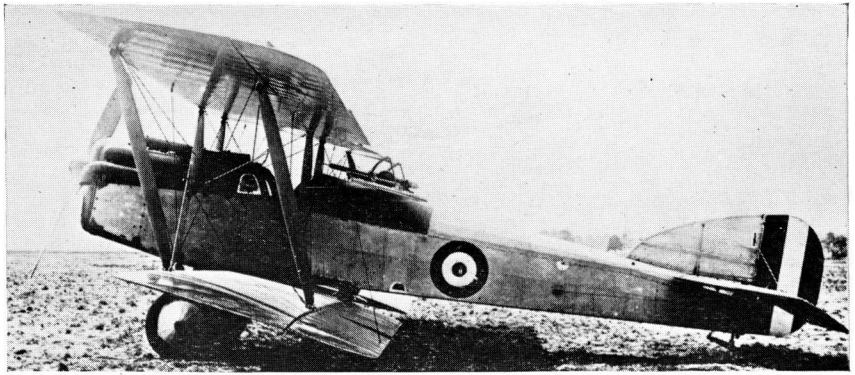


appeared on all subsequent Martinsyde designs.

The installation of the Hispano-Suiza bore a resemblance to that of the Falcon in the original Martinsyde R.G. A large rectangular frontal radiator was fitted, framed in a cambered cowling; there were no radiator shutters.



Martinsyde F.2.



Martinsyde F.2 at Martlesham Heath.

Ailerons were fitted to upper and lower mainplanes. The incidence of the tailplane could be varied in flight, and there was emergency dual control in the observer's cockpit.

The F.2 was tested at Martlesham Heath two months earlier than the F.1. It proved to have pleasant handling qualities, considerable natural stability, a short take-off run, and a remarkably low landing speed. The official report's criticisms were these: "The release pressure valve is out of reach; and the front petrol tank cramps pilot's leg movements. The pilot's view is very bad, especially for landing. The observer's rudder bar is weakly supported, and liable to be broken by standing on. There are no wing skids, and the bottom aileron levers are exposed to ground breakage. The Vickers gun fitting is very weak."

It seems that no attempt was made to modify the F.2 to make it acceptable, and the type was abandoned.

Type: *Two-seat Fighter-reconnaissance.* **Power:** *One* 200 *h.p. Hispano-Suiza* 8*Bd eight-cylinder water-cooled engine.* **Armament:** *One fixed, synchronized* 0.303-*in. Vickers machine-gun; one* 0.303-*in. Lewis machine-gun on Scarff ring mounting.* **Performance:** *Maximum speed,* 120 *m.p.h. at ground level,* 114 *m.p.h. at* 10,000 *ft.,* 107 *m.p.h. at* 15,000 *ft. Climb to* 10,000 *ft.,* 13 *min.* 30 *sec., to* 15,000 *ft.,* 26 *min.* 18 *sec. Service ceiling,* 17,000 *ft. Endurance,* 2½ *hours.* **Weights:** *Empty,* 1,547 *lb.; loaded,* 2,355 *lb.* **Dimensions:** *Span, upper* 32 *ft., lower* 30 *ft.; length,* 25 *ft.; height,* 8 *ft.* 2 *in.; wing area,* 334 *sq. ft.*

MARTINSYDE F.3

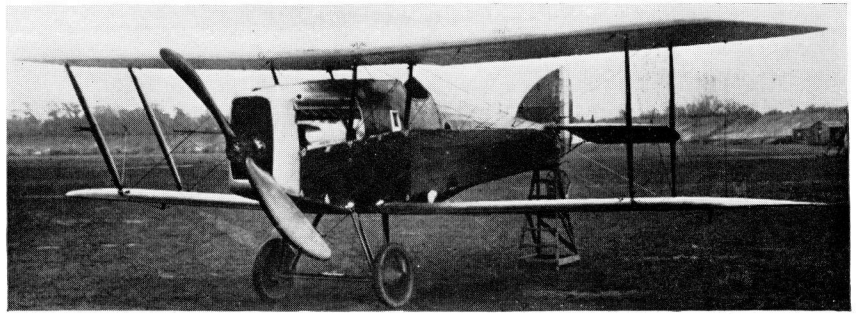
In the autumn of 1917 the Martinsyde F.3 appeared. It was a substantial, handsome single-seat fighter powered by an experimental Rolls-Royce Falcon engine of 285 h.p., and in its design was incorporated all that had been learned from its predecessors. Six prototypes, B1490–B1495, were ordered under Contract No. A.S.29238/17.

The F.3 was designed by G. H. Handasyde. Its airframe was built from the conventional wood, wire and fabric of the period, but its structure incorporated several unusual features. The fuselage longerons were of solid hickory, the spacers of spruce. The forward portion of the fuselage had diagonal spruce members instead of cross-bracing and was covered with plywood; the rear portion was cross-braced with 2 B.A. swaged tie-rods and was fabric-covered. To the basic girder component an unusually deep top-decking was added. In front of the cockpit it provided ample space to house the main fuel tanks and two Vickers guns; aft, it acted as a streamlined head-rest for the pilot. The spars of the lower centre-section were bolted to the underside of the lower longerons and were faired to the fuselage.

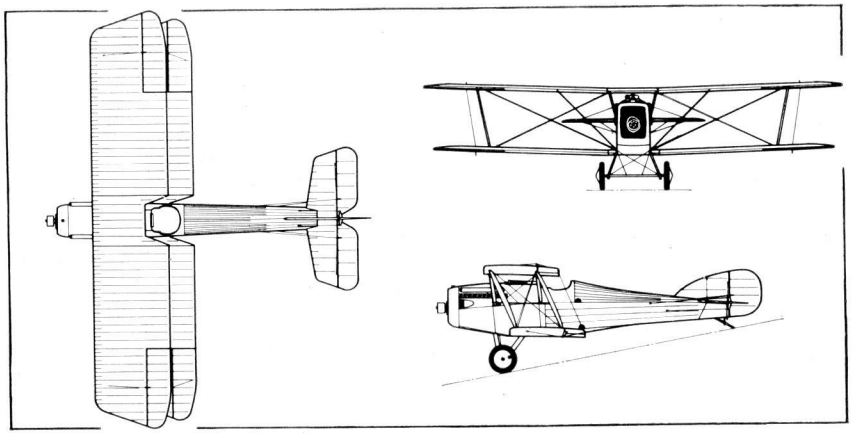
Each spar of the mainplanes was built up of three laminations of spruce. The wings were of equal chord, but the lower was slightly shorter in span than the upper. On the upper surface of each wing a nose covering of $\frac{1}{16}$-inch plywood from leading edge to a depth of 12 mm. behind the front spar was applied. This, and the unusually close spacing of the ribs ensured the accurate preservation of the aerofoil section. The disposition of the flying wires was unusual, and there were auxiliary mid-bay flying wires as on the S.E.5.

The profiles of all tail surfaces were of spruce and were remarkable for their large cross sections. The stern post was a duralumin tube, and the incidence of the tailplane could be altered in flight.

Armament was intended to comply with Air



Martinsyde F.3 with original installation of 285-h.p. Rolls-Royce engine at Brooklands.

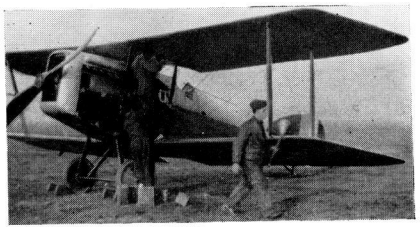


Board specification Type A.1(a), and there was provision for two fixed Vickers guns in the fuselage and a Lewis gun on the rear spar of the upper centre section, which incorporated a special compression member to take up the recoil. It is doubtful whether the Lewis gun was ever fitted, however. Provision was made for the installation of oxygen cylinders in the lower centre section.

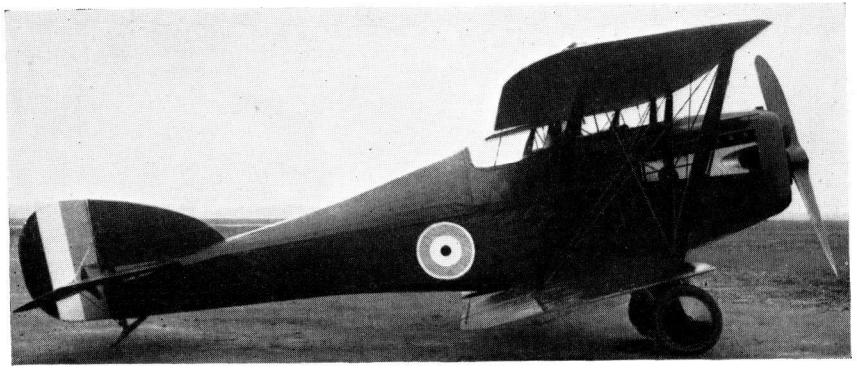
The first F.3 underwent official tests at Martlesham in November 1917, when it recorded performance figures that were considerably superior to those of any British aircraft then in existence. An official report described it as "a great advance on all existing fighting scouts".

At least four of the six F.3s that had been ordered were completed. They went to Home Defence squadrons in 1918; two were on the strength of No. 39 Squadron at North Weald Bassett on 8th June, 1918, and it is believed that B1492 was flown at Biggin Hill.

An engine change, probably to the standard



The original F.3 being refuelled. Believed to be at Orfordness.



Martinsyde F.3, B1490, at Martlesham Heath with 275-h.p. Rolls-Royce Falcon III.

275 h.p. Rolls-Royce Falcon III, was made in B1490. The external appearance of the installation was virtually unchanged, but shutters were fitted to the upper half of the radiator, and the engine drove a right-hand airscrew. With this engine the performance was slightly inferior to that obtained with the earlier one, but it was still excellent. The undercarriage and its bracing were also modified: each wheel was carried on an independently pivoted stub axle, the pivot points being braced to the bottom of the fuselage by wires.

An explicit statement of the precise reason why the F.3 did not go into production has yet to be found, but it is likely that the shortage of Rolls-Royce Falcons was a decisive factor. The precise relationship between the F.3 and F.4 has yet to be determined. Various official documents suggest (but do not specifically state) that production of the F.3 was intended: rigging diagrams and handbooks for the type were prepared. In Appendix XXXII to *The War in the Air* (Price List of various British Airframes and Engines) the F.3 was included: every other aircraft type listed was produced in quantity.

That Appendix lists two forms of Martinsyde F.3, the first with the 300 h.p. Hispano-Suiza, the second with the Rolls-Royce Falcon III. Evidence that an F.3 was actually fitted with a Hispano-Suiza engine has yet to be found, but there can be no doubt that the installation was designed.

Type: *Single-seat Fighter.* **Power:** *One 275 h.p. Rolls-Royce Falcon III, 285 h.p. Rolls-Royce Falcon Experimental twelve-cylinder water-cooled engine.* **Armament:** *Two fixed, synchronized 0.303-in. Vickers machine-guns; one 0.303-in. Lewis machine-gun could be carried above the centre section.* **Performance,**

Falcon Experimental (*Falcon III in brackets*): *Maximum speed*, 138 *m.p.h.* (129.5 *m.p.h.*) *at* 10,000 *ft.*, 132.5 *m.p.h.* (123.5 *m.p.h.*) *at* 15,000 *ft. Climb to* 10,000 *ft.*, 6 *min.* 50 *sec.* (8 min. 5 *sec.*), *to* 15,000 *ft.*, 11 *min.* 55 *sec.* (15 *min.*). *Service ceiling*, 24,000 *ft.* (21,500 *ft.*). *Endurance*, 2½ *hours* (2¼ *hours*). **Weights**, *Falcon Experimental* (*Falcon III in brackets*): *Empty*, 1,790 *lb.* (1,859 *lb.*); *loaded*, 2,325 *lb.* (2,446 *lb.*). **Dimensions:** *Span, upper* 32 *ft.* 10 *in., lower* 31 *ft.* 6 *in.; length*, 25 *ft.* 6 *in.; height.* 8 *ft.* 8 *in.; wing area.* 320 *sq. ft.*

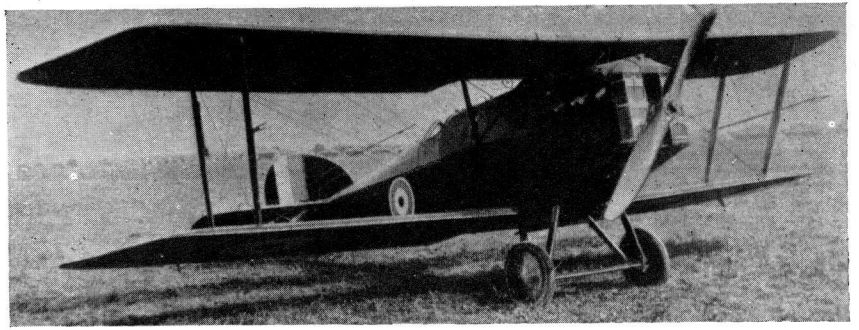
MARTINSYDE F.4 BUZZARD

The Martinsyde F.4 was a direct development of the F.3, which it resembled closely. The resemblance extended to the structure, but the two airframes were not identical. Dimensional data that apparently originated from the Martinsyde company indicates that the F.4 embodied the upper wings and ailerons, tail unit and undercarriage of the F.3; but one official record contains figures that suggest that the F.4 flight surfaces differed very slightly from those of the F.3. New lower wings of slightly reduced chord were fitted, but the disposition of the interplane bracing wires was similar to that of the F.3.

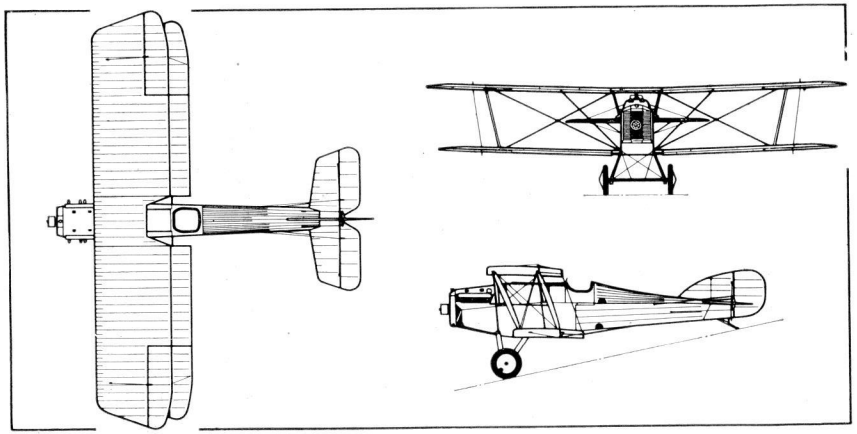
In the F.4 fuselage the basic box girder was virtually unchanged, but the plywood covering of the sides extended farther aft than on the F.3, reducing by one the number of cross-braced bays on each side. The pilot sat farther aft and slightly higher than on the F.3, consequently the shape of the top deckings was different on the F.4.

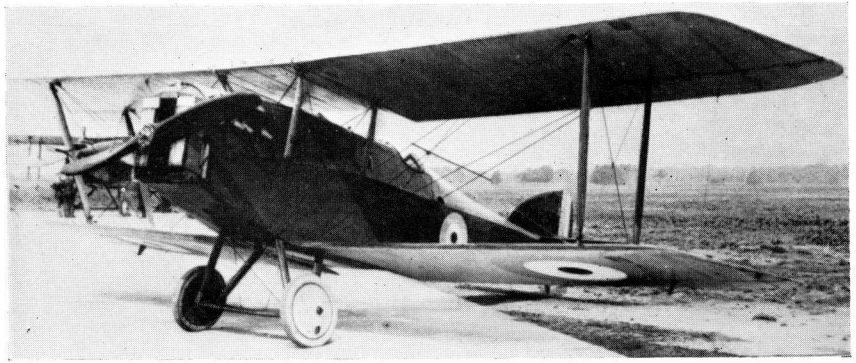
The 300 h.p. Hispano-Suiza engine was to be the standard power unit of the Martinsyde F.4, but an early prototype aircraft was fitted with a Rolls-Royce Falcon, doubtless because no 300 h.p. Hispano-Suiza was available. A Hispano-powered F.4 was officially tested in June 1918, returning excellent performance figures that made the aircraft one of the fastest then in existence. It was comfortable to fly and was manoeuvrable, though not in the highly sensitive way that characterized so many of the fighters of 1918. The pilot had a

Prototype Martinsyde F.4 with Rolls-Royce Falcon engine at Brooklands.



Martinsyde Buzzard with modified radiator, photographed in France.





Production Buzzard D4256 at Martlesham Heath.

good field of view above his aircraft; forwards and downwards his outlook was obscured by the bulky fuselage.

Officially named Buzzard, the F.4 was ordered in quantities, the first contract being for 150 aircraft (D4211–D4360). All of this batch were ultimately built, but by the end of October 1918 a bare four dozen aircraft had been delivered; production continued after the armistice. Other batches totalling 1,300 aircraft were ordered from Martinsyde Ltd., Boulton & Paul, Ltd., Hooper & Co., Ltd., and the Standard Motor Co., Ltd. More than 370 Martinsyde-built Buzzards were completed but it seems that the other firms' contracts were cancelled when the war ended. Production aircraft differed from the Hispano-powered prototype only in the design of the radiator casing and shutters.

A prototype with the Hispano-Suiza engine went to France, where it was tested by the French authorities. The Martinsyde F.4 was subsequently adopted for use by French *Escadrilles de Chasse*, but none had been delivered to French units before the armistice.

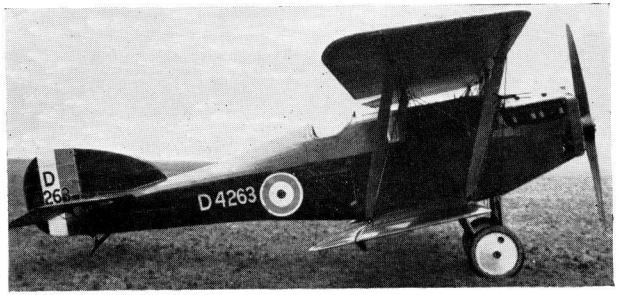
American production of the F.4 was planned, with the American-built 300 h.p. Hispano-Suiza as the power unit. The armistice was signed before production could start, and the contract for 1,500 aircraft was cancelled.

Deliveries to Britain of the 300 h.p. Hispano-Suiza were slow. This may have led to a decision to have an alternative engine for the Martinsyde F.4 as an insurance against delivery hold-ups. With the Rolls-Royce Falcon out of the question (although it was officially regarded as an alternative power unit for the Buzzard) the range of other suitable engines was small. The ultimate selection of the 220 h.p. Lorraine-Dietrich seems to have been dictated by availability, but there may

have been a connexion with France's decision to adopt the Martinsyde. It is not known whether any Martinsyde F.4 was in fact fitted with this engine, but a design for the installation must have been prepared.

For service as an escort fighter to the bombers of the Independent Force, R.A.F., a long-range version designated Buzzard Mk Ia was built. Three prototypes, H6540–H6542, were ordered and at least two were completed; the second, H6541, was at Farnborough on 16th December 1919. The Buzzard Ia could be distinguished from the standard Buzzard I by the wind-driven petrol pump on the front leg of the starboard undercarriage V-strut. It was decided to put the Buzzard Ia into production.

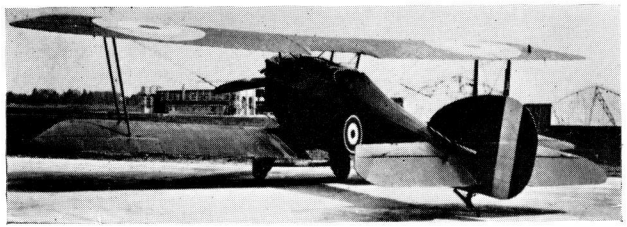
Although official tests of various Buzzards were made during 1919, the type never went into squadron service with the Royal Air Force. On 6th January, 1919, D4263 arrived at Farnborough from Brooklands. It was joined at the R.A.E. by D4264, and these two Buzzards were flown there during the spring of 1919. In November of that year D4269 was reported to be at Farnborough; apparently it had been fitted with an American-built 300 h.p. Hispano-Suiza.



Production Buzzard at R.A.E. Farnborough.

Two Martinsyde F.4s were allotted to the R.A.F. Communication Wing for service between London and Paris during the 1919 Peace Conference, and one of them set up the fastest time over the regular route, covering the 245 miles in 1¼ hours. In 1920 an F.4 took part in the R.A.F. Aerial Pageant.

The Martinsyde company retained a considerable number of F.4 airframes in store after the armistice, and produced a seaplane version and the F.4a two-seat development,



Buzzard at Martlesham Heath.

The first Martinsyde Buzzard Mk.1a.

but the great majority of the F.4s went to the Aircraft Disposal Co. The Martinsyde firm went into liquidation in 1921. A few F.4s were flown for commercial purposes; some were sold to Ireland, Finland, Latvia, Portugal and Spain; one was taken to Japan in 1921 by the British Aviation Mission to the Imperial Japanese Navy; and the A.D.C. converted some to have Lamblin radiators, Armstrong-Siddeley Jaguar and A.D.C. Nimbus engines. Six F.4s were still in service with the Spanish naval air service when the civil war started in Spain in 1936, and one last survivor of the type still exists in Finland.

Type: *Single-seat Fighter.* **Power:** *One* 300 *h.p. Hispano-Suiza* 8*Fb*, 220 *h.p. Lorraine-Dietrich* 8*Bb, both eight-cylinder water-cooled engines*; 275 *h.p. Rolls-Royce Falcon III twelve-cylinder water-cooled engine.* **Armament:** *Two fixed, synchronized* 0.303-*in. Vickers machine-guns.* **Performance** (*production F.*4)**:** *Maximum speed*, 132.5 *m.p.h. at* 15,000 *ft. Climb to* 10,000 *ft.*, 7 *min.* 55 *sec., to* 15,000 *ft.*, 14 *min. Service ceiling*, 24,000 *ft.* **Weights** (*production F.*4)**:** *Empty*, 1,811 *lb.*; *loaded*, 2,398 *lb.* **Dimensions:** *Span, upper* 32 *ft.* 9⅜ *in., lower* 31 *ft.* 2⅜ *in.*; *length*, 25 *ft.* 5⅝ *in.*; *height*, 8 *ft.* 10 *in.*; *wing area*, 320 *sq. ft.*

NESTLER SCOUT

The Westminster firm of F. C. Nestler, Ltd., had taken their first step towards entering the aircraft industry before the outbreak of war when they acquired the British agency for Sanchez-Besa aircraft. During the war they manufactured a portable hangar of their own design and some aircraft components.

In 1916 they decided to set up their own design office and engaged Mons. E. Boudot, a Frenchman, as designer. By August of that year he had completed the design of a small single-seat scout that was built by the Nestler firm as a private venture.

The airframe of the Nestler Scout was a conventional wire-braced, fabric-covered structure. The single-bay wings were of equal span and chord, and differed from most contemporary British aircraft in having no upper centre section: the halves of the upper wing met at a central trestle-shaped cabane. Ailerons were fitted to upper and lower wings.

Power was provided by a rotary engine,

The Nestler Scout.

apparently a 100 h.p. Gnôme Monosoupape. There was no frontal aperture in the cowling, its lower portion being cut away much as on the original Bristol Scout A and the Fokker Dr.I. A spinner was fitted to the airscrew. The fuselage was comparatively commodious for such a small aircraft. The pilot sat in line with the trailing edge of the lower wing, and there was a headrest behind the cockpit. Undercarriage and tail unit were conventional, but there was no fin; the rudder looked a little like that of the Bristol Scout and was similarly balanced.

The Nestler proved to be as manoeuvrable as its compact appearance suggested. For the test flying of the aircraft the company engaged J. B. Fitzsimmons, who frequently demonstrated the Scout's aerobatic qualities at Hendon. On 26th March, 1917, the aircraft crashed and was completely wrecked; Fitzsimmons lost his life.

The Nestler Scout was too extensively damaged to be rebuilt. It is believed that it was not the only aircraft designed by Boudot for the Nestler firm, and a reference to a "Nestler 110 Clerget Biplane Scout H.N.2" has survived. It is not known whether the H.N.2 was built. In its designed form it had the oddly disparate factors of safety of 7.55 on the front spars and 3.1 on the rear; the latter value was considerably lower than the corresponding factor in other contemporary British fighter aircraft. The Air Board specification A.1(a) of April 1917 stipulated a minimum factor of 8 on the front truss of single-seat tractor aircraft, 6 on the rear.

Type: *Single-seat Scout.* **Power:** *One 100 h.p. Gnôme Monosoupape nine-cylinder rotary engine.* **Armament:** *No details available.* **Performance:** *No details available.* **Weights:** *No details available.* **Dimensions:** *No details available.*

NIEUPORT B.N.1

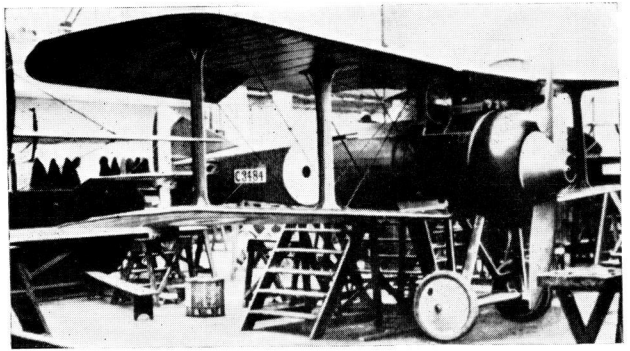
When the technical staff of the Royal Aircraft Factory was dispersed in 1917 after the Bailhache Judicial Committee had examined the administration and command of the Royal Flying Corps and the Burbidge Committee the affairs of the Royal Aircraft Factory, the Nieuport & General Aircraft Co., Ltd., of Cricklewood, engaged Major S. Heckstall-Smith and H. P. Folland, former members of the Farnborough establishment.

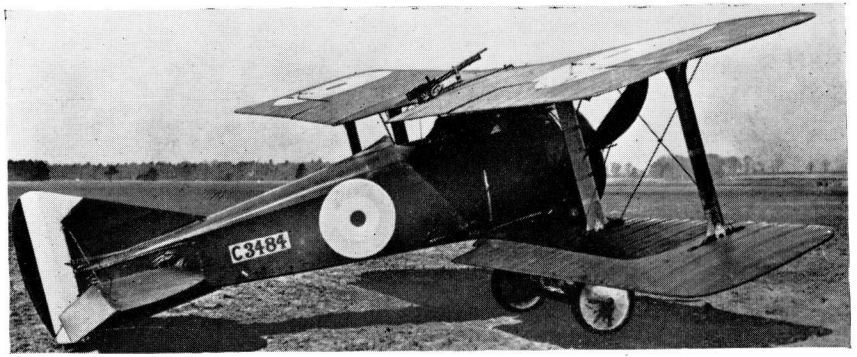
The Nieuport company had been set up for the manufacture of French Nieuport designs in Britain. With single-seat fighters in production in the Cricklewood works and Folland fresh from the design work on the S.E.5, it is perhaps not surprising that the first design turned out by the Nieuport & General Aircraft Co. was also a single-seat fighter. The aircraft was designated B.N.1 and was powered by a 230 h.p. Bentley B.R.2 rotary engine.

Several Folland features were apparent in the B.N.1. The large conical spinner, closely-cowled engine and I-type interplane struts were reminiscent of the S.E.4 of 1914; the under-fin and tail-skid were similar to those of the S.E.5. The two-bay wings were of unequal chord; ailerons were fitted to the upper mainplane only. The pilot sat just behind the centre-section struts, where his field of view must have been restricted, despite the large cut-out in the trailing edge. As required by the Air Board specification A.1(a) the armament consisted of twin Vickers guns and a Lewis gun on a neat mounting on the centre section.

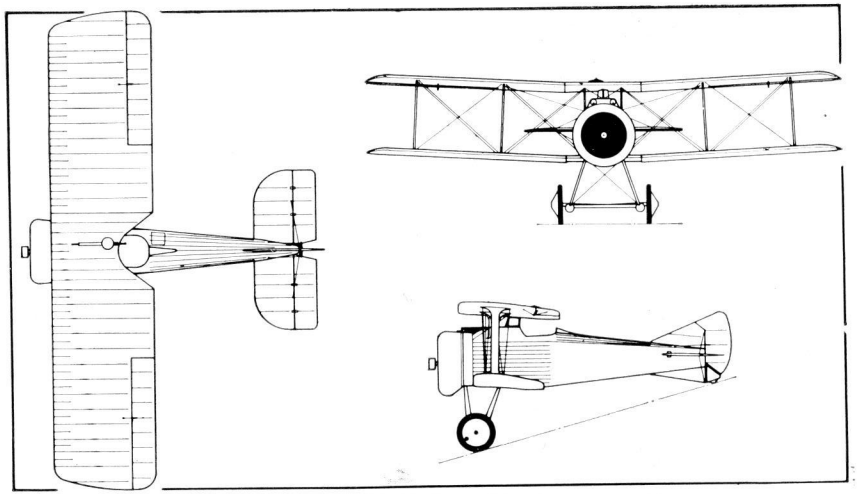
Construction was basically conventional,

The Nieuport B.N.1 in its original form with spinner and, below, with spinner removed.

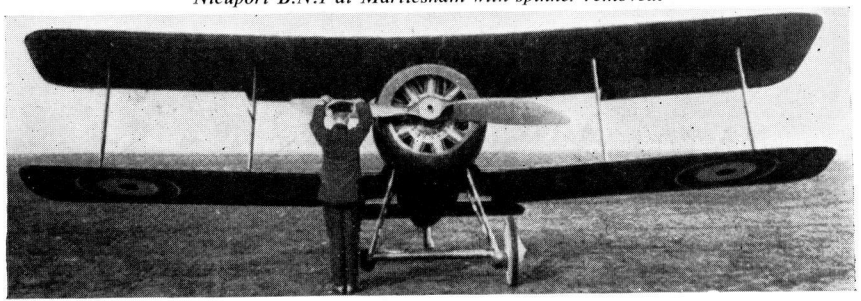




but the upper mainplane was unusual in having three full-span main spars. The rearmost spar carried the ailerons; the other two were attached to the interplane struts. For ease of production there were no machined metal fittings, pressings being used throughout. The equipment included oxygen apparatus and electric heating for the pilot's flying clothing.



Nieuport B.N.1 at Martlesham with spinner removed.



Three prototypes, C3484–C3486, were ordered, but only the first was completed. It was assembled towards the end of 1917, but flight testing was delayed owing to the lack of an engine. A B.R.2 was allocated in February 1918, and on 1st March the B.N.1 was flown to Martlesham Heath. The engine of C3484 proved to be so consistently refractory (it was apparently the sixth B.R.2 to be made) that performance trials could not be carried out.

On 9th March, 1918 the B.N.1 was sent to Sutton's Farm, a Home Defence aerodrome, apparently for some kind of comparative tests with the Austin Osprey, Boulton & Paul Bobolink and Sopwith Snipe, all of which were also there. On 10th March, while flying from Sutton's Farm, the Nieuport B.N.1 caught fire in the air and was destroyed. No further development was undertaken, presumably because the Nighthawk was in prospect.

Type: *Single-seat Fighter.* **Power:** *One* 230 *h.p. Bentley B.R.2 nine-cylinder rotary engine.* **Armament:** *Two fixed, synchronized* 0.303-*in. Vickers machine-guns; one movable* 0.303-*in. Lewis machine-gun.* **Performance:** *Maximum speed,* 127 *m.p.h. at* 15,000 *ft. Climb to* 15,000 *ft.,* 16 *min. Ceiling,* 26,000 *ft. Endurance,* 3 *hours.* **Weight:** *Loaded,* 2,030 *lb.* **Dimensions:** *Span,* 28 *ft.; length,* 18 *ft.* 6 *in.; height,* 9 *ft.; wing area,* 260 *sq. ft.*

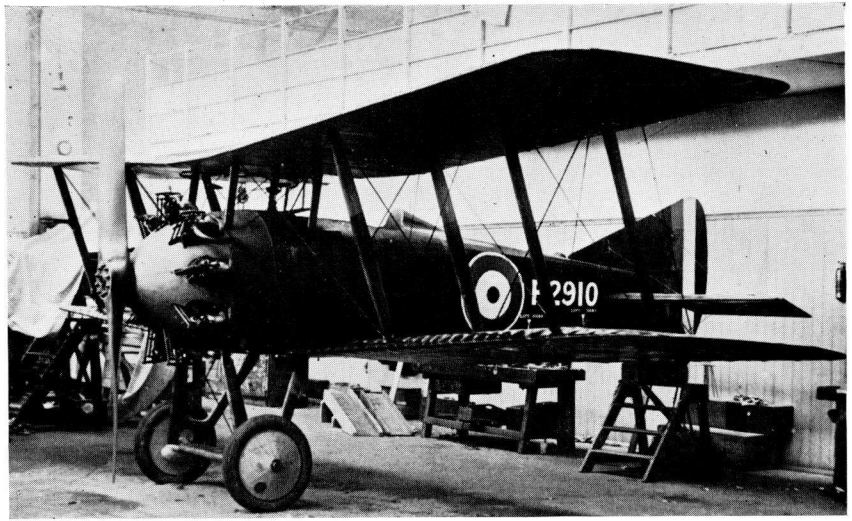
NIEUPORT NIGHTHAWK

In April 1917, A.B.C. Motors, Ltd., were invited to submit aero-engine designs for the 1918 engine programme. In August 1917 they received a contract for three prototype nine-cylinder radials to be called Dragonfly. The preliminary success of their seven-cylinder Wasp in its early trials in October encouraged their designer, Granville Bradshaw, to urge the adoption of the Dragonfly in preference to the Wasp. It was claimed for the Dragonfly that it would deliver 340 h.p. and would weigh little more than 600 lb., a prodigious performance for those days.

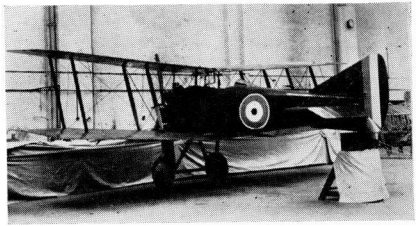
In 1918 large-scale production of the Dragonfly began, and aircraft designers eagerly sought to exploit the engine's promised capabilities in new types of aircraft. Among the various single-seat fighters designed to have the A.B.C. radial was the Nieuport Nighthawk, a well-proportioned two-bay biplane designed by H. P. Folland.

The Nighthawk was a conventional aircraft that struck an excellent balance between ease of production and aerodynamic refinement. As was usual in Folland-designed aircraft, detail design was excellent. The usual materials of wood, wire, plywood and fabric went into the airframe. The fuselage had side fairings, which were utilized to contain the main fuel tanks. These were Imber self-sealing tanks, shaped to the contours of the fuselage. The pilot sat farther aft than on the B.N.1; his two Vickers guns were mounted under the top decking. Conventional interplane struts were employed, and ailerons were fitted to upper and lower mainplanes. The tail unit closely resembled that of the B.N.1.

Three prototypes, F2909–F2911, were ordered; work on the first began in May 1918. Its proof-loading tests, made in September, were so satisfactory that the Nighthawk was ordered in quantity before a prototype had flown. It was the only one of all the many types designed for the Dragonfly to go into production (the Sopwith Dragon was a mere conversion of the Snipe). Another decision



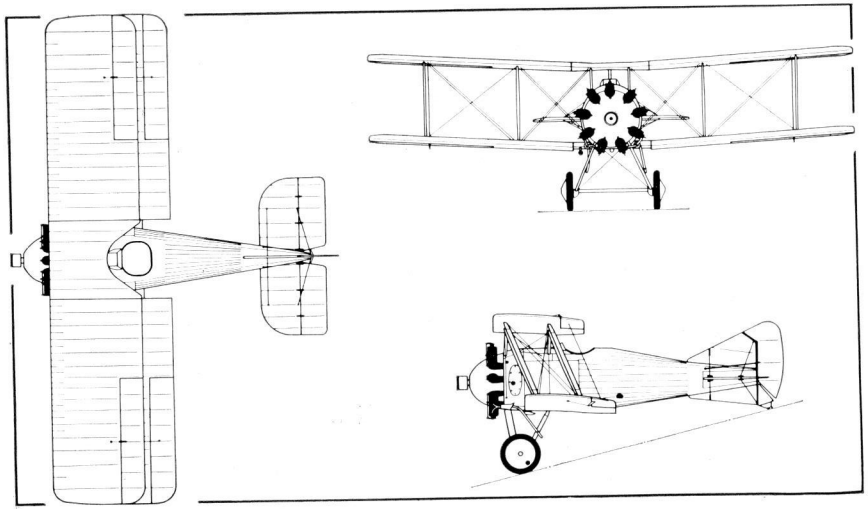
Nighthawk prototype F2910 with fairings on centre-section struts.



Prototype Nighthawk, probably F2910.

taken before a prototype Nighthawk had flown was that the type should be tested as a shipboard fighter.

By this time the A.B.C. Dragonfly engine was in serious trouble. Its output was only 295 h.p., cooling difficulties were experienced, it vibrated badly, and its useful life was only one or two hours. Nevertheless, production of the Nighthawk was started, doubtless in

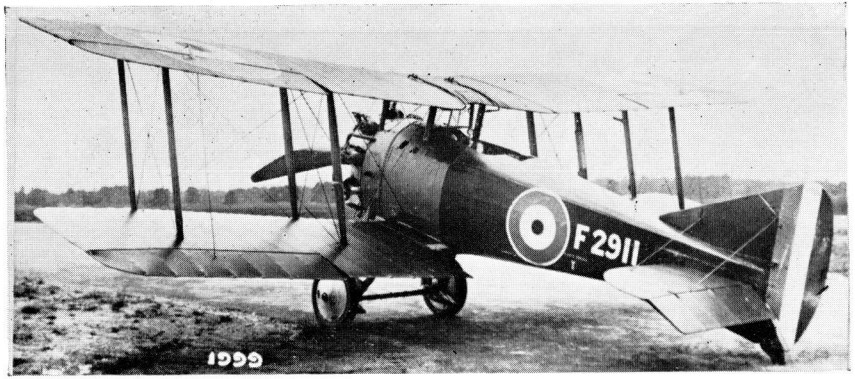


the hope that the engine's faults would be cured. A contract for Snipes given to the Nieuport company was changed to consist of Nighthawks, and the Gloucestershire Aircraft Co., Ltd., of Cheltenham were given an order for the type. But the armistice overtook the Nighthawk programme; the incurable defects of the Dragonfly virtually killed the design.

The second prototype, F2910, was probably the first Nighthawk to fly. As originally built, it had a headrest behind the cockpit; but F2911 dispensed with this refinement, having in its place a rectangular slot in the top decking. This third prototype, F2911, was tested at Martlesham Heath in July 1919.

In the air the Nighthawk had delightful handling qualities and was an ideal aerobatic aeroplane. If it had had a reliable engine it would have been an excellent fighter.

Production aircraft from both contractors appeared late in 1919, but none saw service with any R.A.F. squadron. The cancellation of the Dragonfly contracts when only 1,147 engines had been made led in turn to the stopping of Nighthawk production. A few Nighthawks continued to be flown at Farnborough for experimental purposes; one (H8553) was fitted with a hydrovane, presumably with shipboard use in view, and was tested at the Isle of Grain; and the Nieuport

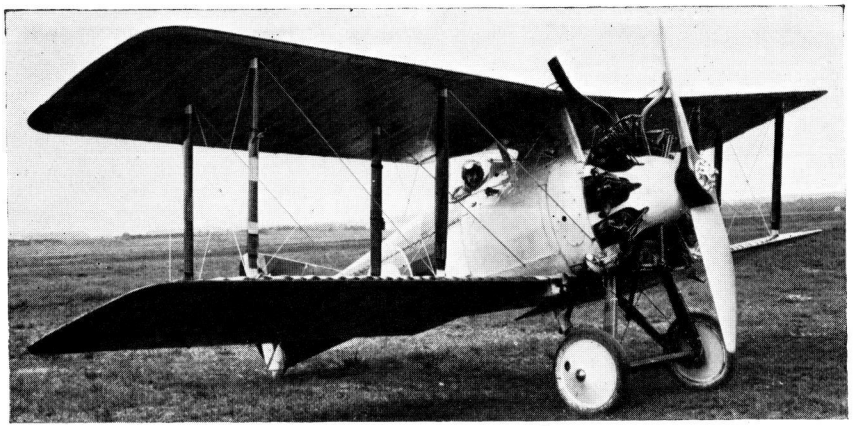


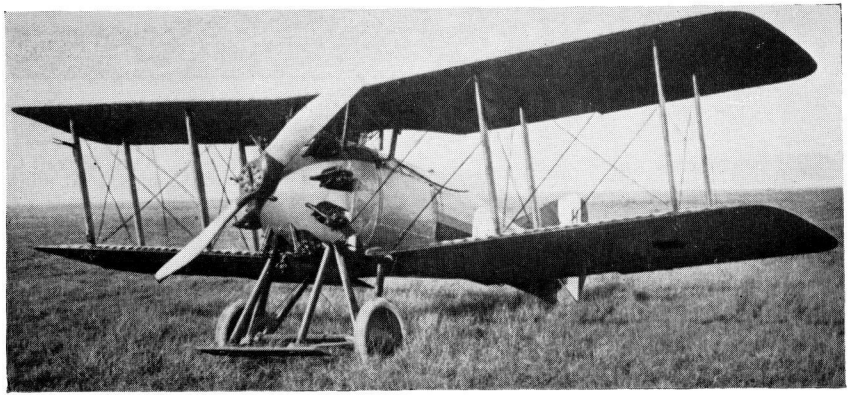
(*Above*) *The third prototype Nighthawk at Martlesham Heath.*

(*Above and left*) *Production Nighthawk H8533.*

company modified two for sporting flying under the name Nieuhawk.

After the Nieuport firm closed down in August 1920, the Gloucestershire Aircraft Co. converted a number of the unused Nighthawk airframes into various types in their Mars series. The name Nighthawk was revived for the Mars VI, which had a 325 h.p. Armstrong-Siddeley Jaguar II or III or a 385 h.p. Bristol Jupiter III. The only sales of these derivatives were made to foreign countries, apart from the small number of Mars X Nightjars that saw brief service with the R.A.F. in 1921–24. The Nighthawk itself had been declared obsolete in 1923.





Left, above, Nighthawk at the R.A.E. with modified Dragonfly engine.

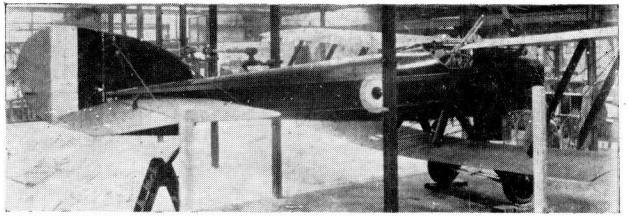
Left, below, Nighthawk H8553 with hydrovane on undercarriage.

Type: *Single-seat Fighter.* **Power:** *One 320 h.p. A.B.C. Dragonfly I nine-cylinder radial engine.* **Armament:** *Two fixed, synchronized 0.303-in. Vickers machine-guns.* **Performance:** *Maximum speed, 151 m.p.h. at ground level, 138.5 m.p.h at 10,000 ft., 134 m.p.h. at 15,000 ft. Climb to 10,000 ft., 7 min. 10 sec., to 15,000 ft., 12 min. 40 sec. Service ceiling, 24,500 ft. Endurance, 3 hours.* **Weights:** *Empty, 1,500 lb.; loaded, 2,218 lb.* **Dimensions:** *Span, 28 ft.; length, 18 ft. 6 in.; height, 9 ft. 6 in.; wing area, 276 sq. ft.*

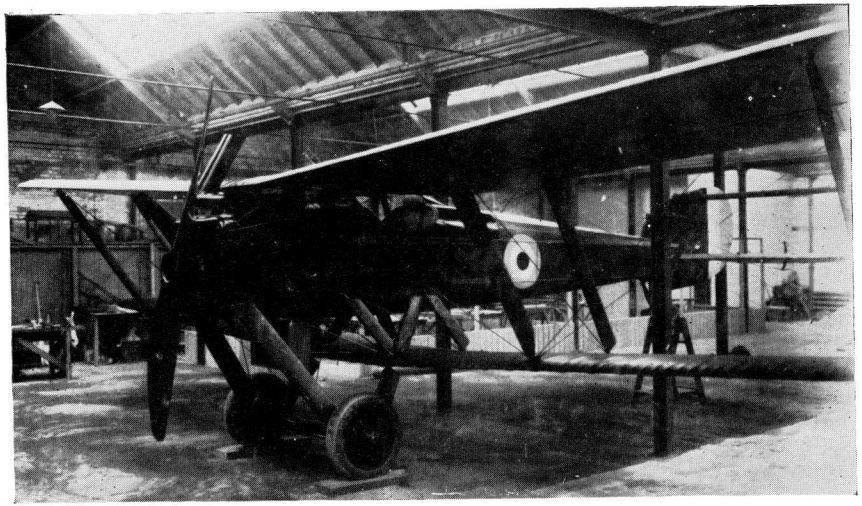
PARNALL SCOUT

The depredations of German airships necessitated the creation, throughout 1915 and 1916, of a defensive system of guns and aircraft to protect the British Isles. In February 1916 it was decided that the Navy would be responsible for attacking all hostile aircraft approaching the United Kingdom, whilst the Army would deal with those that reached British shores. This probably led to an Admiralty requirement for a land-based aeroplane capable of destroying enemy airships. Certainly the Bristol firm of Parnall and Sons built such an aircraft in 1916. It was a large single-seat biplane designed by A. Camden Pratt, unofficially known as the Zeppelin Chaser, Zepp Strafer, or Night Flyer.

To give the pilot the best possible upward view the upper wing was mounted close to the fuselage and there was a large gap between the fuselage and the lower wing. The cockpit was unusually commodious, with the single Lewis gun mounted to starboard at an upward angle of 45°. Doubtless this arrangement of the armament was adopted as a result of the experiments conducted at the Armament Experimental Station at Orfordness. These indicated that a bullet fired from a Lewis gun at an upward angle of 45° from an aircraft flying at 100 m.p.h. maintained a straight course up to 800 yards. This fact was of considerable importance in attacking airships,



The Parnall Scout.



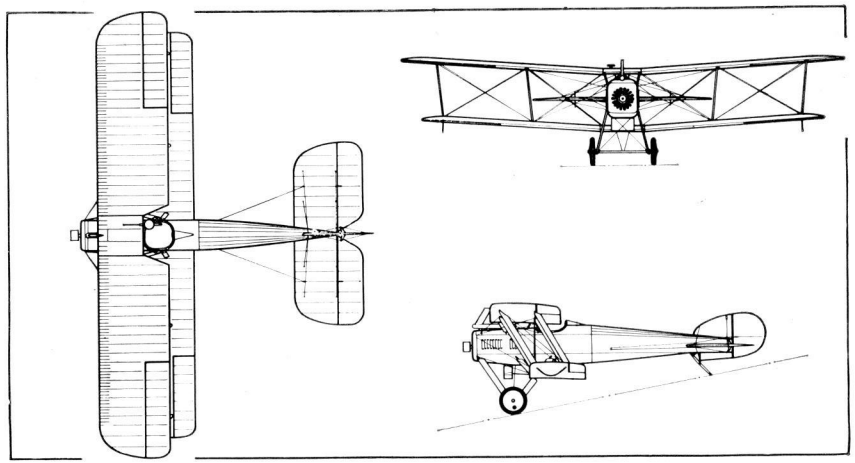
Parnall Scout.

and its usefulness was enhanced by the introduction of incendiary ammunition in the spring of 1916.

The Parnall Scout was of striking appearance. The wings were of unequal span and chord, and were heavily staggered; ailerons were fitted to upper and lower wings. So heavy was the stagger that the flying wires ran from the strut anchorages on the lower front spar only to both upper spars; this must have imposed considerable loads on the front spar of the lower mainplane. All struts, interplane and undercarriage, had massive fairings.

In the fuselage the basic box girder was wide but unusually shallow. Deep top deckings and a full-length belly fairing gave the fuselage good lines, and there was a head-rest behind the cockpit. The variable-incidence tailplane and elevators were remarkably large, and the vertical tail assembly resembled that of the Bristol Fighter.

Two aircraft, N505 and N506, were ordered under Contract No. C.P. 124455/16/24486. The first machine was to have a 200 h.p. Sunbeam engine that may have been the little-known Afridi, the progenitor of the Maori, the second a 190 h.p. Rolls-Royce. In the event, only N505 was built, powered by a 260



h.p. Sunbeam Maori. This engine had a fretted square front to its cowling, a substantial central exhaust stack, and an underslung radiator. Each landing wheel was carried on a separate half axle and was independently sprung; the central pivot point was braced to the bottom of the fuselage by two wires.

When completed the aircraft proved to be considerably heavier than the estimated weight. It is not known whether it was ever flown; the performance figures quoted below are believed to be estimates. The Scout was sent to Upavon to be tested, but stress calculations made there showed its factors of safety to be unacceptably low and the aircraft was condemned as unsafe. It was returned to its makers, who had it broken up and burned; and it has been reported that the drawings and design data were burned with it.

During the inter-war years Mr. Camden Pratt worked in the Vickers design office. This doubtless accounts for the strong resemblance between the Parnall Scout and such later aircraft as the Vickers Vespa.

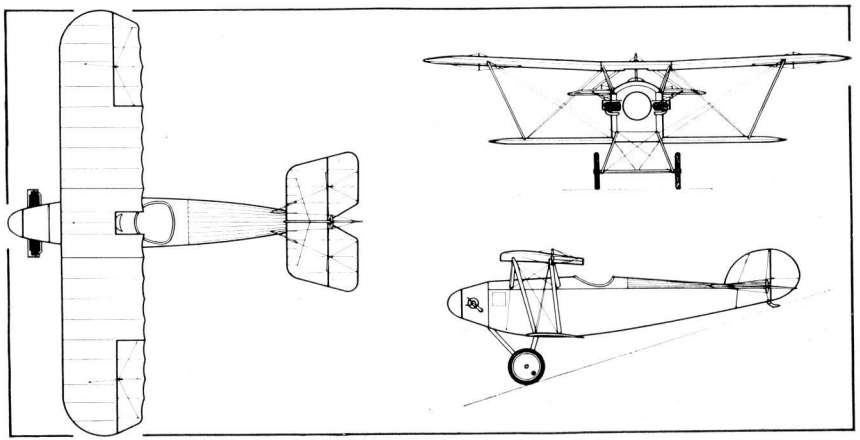
Type: *Single-seat anti-airship Fighter.* **Power:** *One* 260 *h.p. Sunbeam Maori twelve-cylinder water-cooled engine.* **Armament:** *One* 0.303-*in. Lewis machine-gun.* **Performance:** *Maximum speed,* 113.5 *m.p.h. at ground level,* 101.5 *m.p.h. at* 10,000 *ft.* **Weights:** *No details available.* **Dimensions:** *Span, upper* 44 *ft., lower* 40 *ft.; wing area,* 516 *sq. ft.*

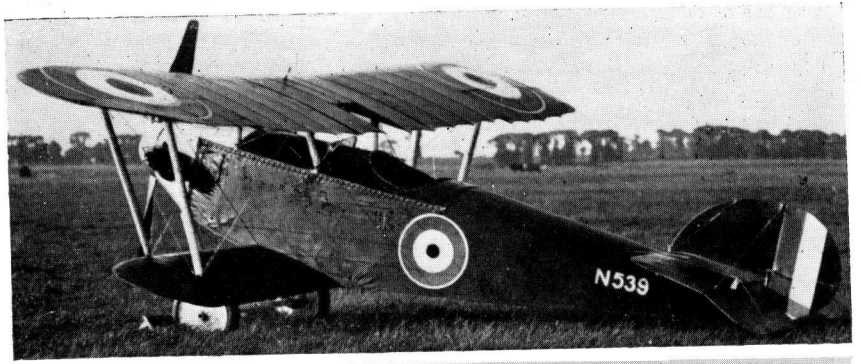
PORT VICTORIA P.V.7 THE GRAIN KITTEN

By the end of 1916 it had been proved that airships could be shot down by incendiary ammunition fired by an ordinary Lewis gun, and that cumbersome armaments like Ranken Darts, bombs and rockets were both difficult to deliver and inadequate. The potential anti-airship capabilities of single-seat scouts flown from vessels at sea had been demonstrated on 2nd August 1916, when a Bristol Scout from H.M.S. *Vindex* attacked a Zeppelin. Early in 1916 it was decided that Sopwith Pups should replace the Sopwith Baby seaplanes of H.M.S. *Manxman* and *Campania*. The light wing-loadings of the time permitted the use of very short flight decks; this led naturally to the development of small flight platforms mounted on ships' gun turrets and suggested that light fighters might be flown from similar abbreviated decks on small sea-going craft.

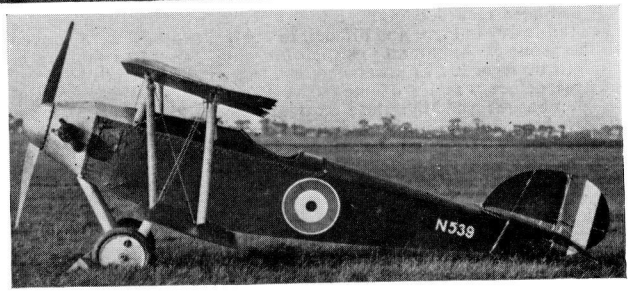
With the object of providing numerous airship-interceptor aircraft always at sea, the Admiralty set about investigating the possibility of building a single-seat scout, small enough to be flown from torpedo-boat destroyers and similar craft, yet capable of carrying a Lewis gun. The problem of designing such an aircraft was laid before the R.N.A.S. Experimental Construction Depot at Port Victoria and the Experimental Flight at Eastchurch; each unit produced a design to meet the requirement.

The earlier products of the Port Victoria E.C.D. had all been floatplanes; its only landplane designs, the P.V.3 and P.V.6, had not been built. The earlier designs had embodied some unusual and advanced features, several having high-lift wing sections. To meet the new Admiralty requirement it was obvious that a landplane design would be essential: on this Port Victoria and Eastchurch agreed, but their two aircraft differed greatly.





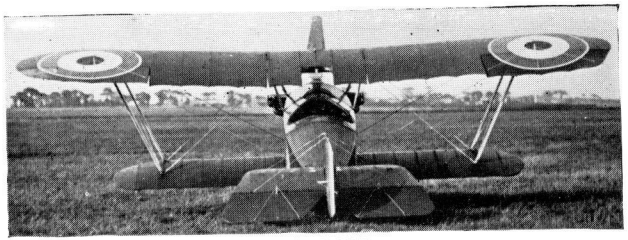
Port Victoria P.V.7, the Grain Kitten.



Designated P.V.7, the aircraft produced by the E.C.D. was designed by W. H. Sayers. It was a tiny single-bay biplane, conventional in construction and in appearance. The sesquiplane wings had the thick, high-lift aerofoil section that had been pioneered on the P.V.1; only the upper mainplanes had ailerons. The Lewis gun was carried centrally above the centre section, which had a rectangular cut-out in its trailing edge to accommodate the gun breech. The shape of the fin and rudder

was similar to that of the P.V.2, P.V.5 and P.V.5a seaplanes.

The P.V.7 was designed for the 45 h.p. A.B.C. Gnat, a horizontal twin-cylinder engine with a reduction gear. This engine was not available, however, and the aircraft was fitted with the 35 h.p. direct-drive A.B.C, Gnat. It was intended that the all-up weight should be under 520 lb. This aim was achieved with some 20 lb. to spare when the load consisted of the Lewis gun, three drums of ammunition, fuel for 2½ hours, and a 10-stone pilot.



The P.V.7.

It has been recorded that the P.V.7 proved to be tail-heavy in flight and difficult to control on the ground. Apparently its high-lift wings came to be regarded as unsatisfactory, but its greatest defect was its engine. The P.V.7's designer has recorded that the aircraft "... was useless because the only engine that ever survived more than an hour's flying was the hand-made prototype originally fitted to it; 'production' engines gave up regularly on their first flight".

Among the few pilots who flew the P.V.7 was Major W. G. Moore, O.B.E., D.S.C., and he has recalled that he seldom completed a flight without one plug oiling up and cutting out half the engine; consequently it was necessary to stay within gliding distance of Eastchurch or the Isle of Grain.

The P.V.7 was named Grain Kitten to distinguish it from the Eastchurch design, the P.V.8, and was flying by September 1917. It was officially tested on 6th October, 1917. Performance was regarded as disappointing; in particular, its service ceiling of 11,900 ft. held out scant hope that it would be able to reach enemy airships. With a view to improving the P.V.7's handling characteristics it was later fitted with new wings of conventional aerofoil section; the tail unit was modified to correct the tail-heaviness and the landing wheels were moved forward to improve the aircraft's taxi-ing behaviour.

Apparently the aircraft was not flown again after these modifications were made. No doubt its abandonment was attributable to the development of means of using ordinary Service aircraft as anti-airship fighters, and to the realization that the A.B.C. Gnat engine was not capable of improvement.

Type: *Single-seat Shipboard Fighter.* **Power:** *One* 35 *h.p. A.B.C. Gnat two-cylinder air-cooled engine.* **Armament:** *One* 0.303-*in. Lewis machine-gun.* **Performance:** *Maximum speed,* 89 *m.p.h. at* 2,000 *ft.,* 85 *m.p.h. at* 6,500 *ft.,* 74 *m.p.h. at* 10,000 *ft. Climb to* 6,500 *ft.,* 10 *min.* 50 *sec., to* 10,000 *ft.,* 22 *min. Service ceiling,* 11,900 *ft.* **Weights:** *Empty,* 284 *lb.; loaded,* 491 *lb.* **Dimensions:** *Span, upper* 18 *ft., lower* 12 *ft.* 7 *in.; length,* 14 *ft.* 11 *in.; height,* 5 *ft.* 3 *in.; wing area,* 85 *sq. ft.*

PORT VICTORIA P.V.8 THE EASTCHURCH KITTEN

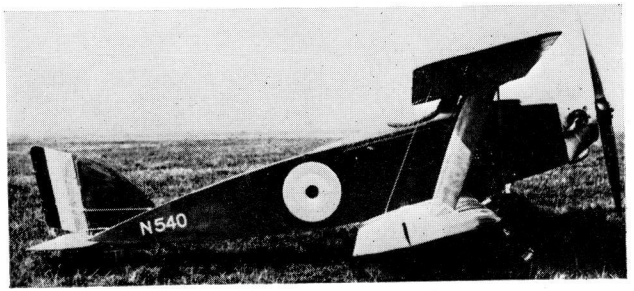
The aircraft built by the R.N.A.S. Experimental Flight at Eastchurch to meet the Admiralty's requirement for a small shipboard scout differed considerably from the Port Victoria P.V.7. It was designed by Lieutenant G. H. Millar, R.N.V.R., who was the chief technical officer of the Experimental Flight, which at that time was commanded by Commander Harry Busteed.

While the aircraft was under construction, Busteed was given the command of the Port Victoria unit. When he moved there he took with him the partly finished airframe, and it was completed alongside the P.V.7. It was given the Port Victoria designation P.V.8 and was named Eastchurch Kitten to distinguish it from the P.V.7 Grain Kitten.

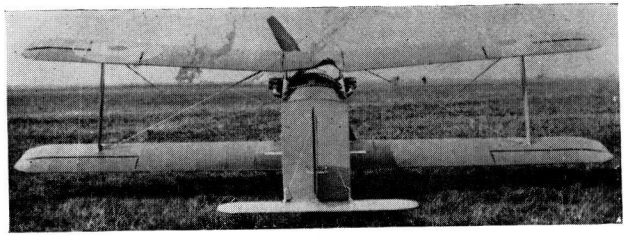
Like the P.V.7, the Eastchurch Kitten was a tiny single-seat biplane designed for the 45 h.p. geared A.B.C. Gnat. It was slightly larger and appreciably heavier than the Grain design, but its larger wing area gave it a lighter wing loading. The P.V.8 looked more angular than the P.V.7, having heavily staggered mainplanes with plank-type interplane struts, dihedral on the upper wing only, and a parallelogram-shaped rudder. The fuselage tapered to a horizontal knife-edge at the stern; there was no tailplane, only a balanced elevator surface.

The undercarriage was a rigid structure, depending for shock absorption on the large-diameter tyres. To give the flying wires a more favourable angle they were taken through the undercarriage axle and anchored to its opposite ends. The official report on the P.V.8 includes the protest that: "If the undercarriage was broken in getting off, or the axle bent, the wings might fold up or be badly strained." The pilot sat in line with the trailing edge of the upper wing. His Lewis gun was on the centre section, offset to starboard; there was a small rounded cut-out in the centre-section trailing edge under the gun to facilitate its elevation. The test report noted that the gun "would be very awkward to fire owing to cramped position of pilot".

For lack of a 45 h.p. A.B.C. Gnat the P.V.8 was obliged, like the P.V.7, to have a 35 h.p. direct-drive Gnat. It was the second

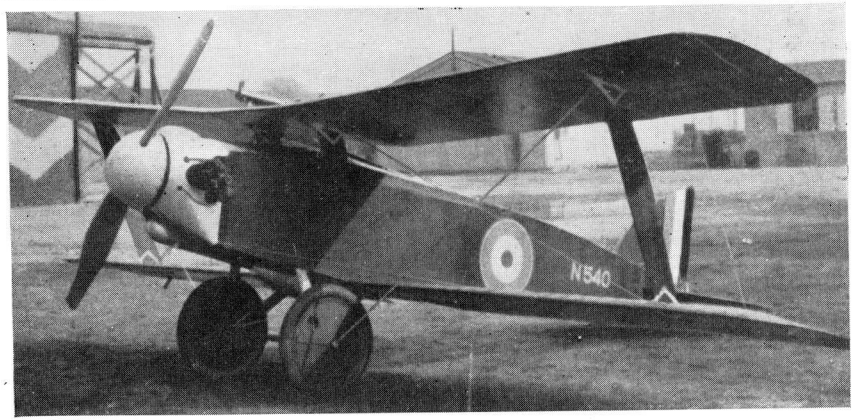


Port Victoria P.V.8 in its original form without tailplane.



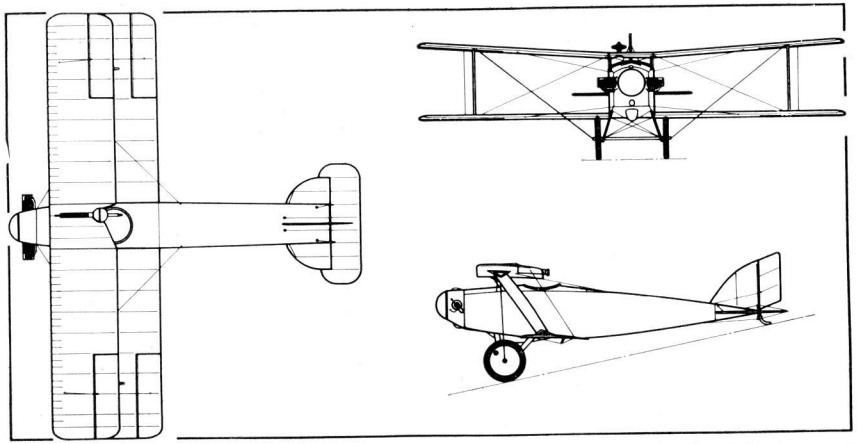
Port Victoria P.V.8 in its original form without tailplane.

P.V.8 in its final form.

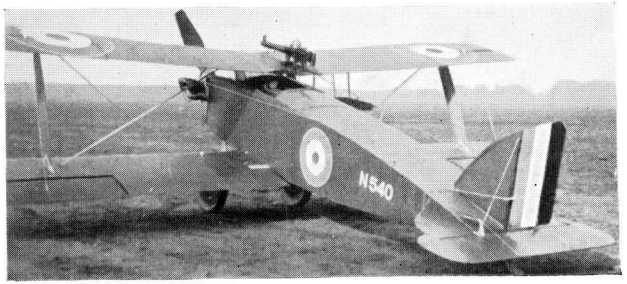


of the two Kittens to fly. On its first flight it displayed serious longitudinal instability, and the horizontal tail surfaces were revised. A small tailplane was fitted, the new elevator having small horn balances.

This sufficed to make the P.V.8 a pleasant aeroplane to fly, and it proved to be better than the P.V.7 in every way. Its official performance tests were flown on 11th October, 1917, when it carried more than twice as much petrol as the P.V.7 and returned better performance figures. If it had had 45 h.p. from a reliable engine it might have been a practical anti-airship weapon. With its unreliable 35 h.p. Gnat the P.V.8 suffered the same troubles as the P.V.7: it was not uncommon for the engine to need special sparking plugs for starting, a change to different plugs being made when it had warmed up.



Martlesham was not enthusiastic about the P.V.8, however. Although conceding that the



P.V.8 in its final form.

view from the cockpit was good and that the aircraft was "very quick on all controls", the official test report stated that it was too fragile for ordinary land work and listed the following criticisms: "The rudder bar needs lifting and larger stops are required, as the foot vibrates off. Engine vibrates considerably and the wires and fittings on the bay of the fuselage next to the engine constantly break or become loose. Compression struts would probably be an improvement. Strength of fittings, owing to the thin metal used, cannot be relied on. It would be advisable to increase the strength of all fuselage fittings."

The ultimate fate of the Kittens is unknown. With all their faults, they deserved something better than their descent into obscurity.

Type: *Single-seat Shipboard Fighter.* **Power:** *One* 35 *h.p. A.B.C. Gnat two-cylinder air-cooled engine.* **Armament:** *One* 0.303-*in. Lewis machine-gun.* **Performance:** *Maximum speed,* 94.5 *m.p.h. at* 2,000 *ft.,* 87.5 *m.p.h. at* 6,500 *ft.,* 84 *m.p.h. at* 10,000 *ft.,* 78 *m.p.h. at* 15,000 *ft. Climb to* 6,500 *ft.,* 11 *min., to* 10,000 *ft.,* 20 *min.* 10 *sec., to* 15,000 *ft.,* 47 *min. Service ceiling,* 14,900 *ft.* **Weights:** *Empty,* 340 *lb.; loaded,* 586 *lb.* **Dimensions:** *Span,* 18 *ft.* 11½ *in.; length,* 15 *ft.* 7½ *in.; height,* 5 *ft.* 2 *in.; wing area,* 106 *sq. ft.*

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